FUNCTIONAL OUTCOME OF TENSION BAND WIRING OF TRANSVERSE FRACTURE OF PATELLA OR OLECRANON OR MEDIAL MALLEOLUS

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CERTIFICATE

This is to certify that this dissertation entitled **"Functional Outcome Of Tension Band Wiring Of Transverse Fracture Of Patella Or Olecranon Or Medial Malleolus"** is a bonafide record of the work done by **Dr. Ansar Muhammed S** under guidance and supervision in the Department of Orthopaedics during the period of his postgraduate study for **M.S. Orthopaedics [Branch-II]** from 2015-2018.

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DECLARATION

In the following pages is presented a consolidated report of the study **"Functional Outcome Of Tension Band Wiring Of Transverse Fracture Of Patella Or Olecranon Or Medial Malleolus"** on cases studied and followed up by me at Sree Mookambika Institute of Medical Sciences, Kulasekharam from 2015-2018. This thesis is submitted to the Dr. M.G.R. Medical University, Chennai in partial fulfilment of the rules and regulations for the award of MS Degree examination in Orthopaedics.

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Dr. Ansar Muhammad S

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LIST OF ABBREVATIONS USED

AO	-	Arbeitsgemeinschaft für Osteosynthesefragen (Association of Osteosynthesis)
TAW	-	Traction absorbing wire
K-wire	-	Kirschner's wire
TBW	-	Tension Band Wiring
OL	-	Olecranon
MM	-	Medial Malleolus
D	-	Direct injury
ID	-	Indirect injury

ABSTRACT

Background and Objectives:

The transverse fracture of patella, olecranon, middle malleolus and its complication accounts for significant morbidity and mortality. Tension band wiring helps in early mobilization of the patients than any other methods of treatment at present.

Materials and methods:

A study of fracture of patella, olecranon and middle malleolus requiring surgical treatment at orthopaedics department of Sree Mookambika institute of Science, 60 patients were operated by tension band wiring technique in our study. Patients were evaluated for functional outcome by using different scores. Patients were also evaluated radiologically.

Results

The result of our study shows that effectiveness of the procedure was recorded 85% for patella which was one of the highest assigned to the procedure.

Conclusion:

Considering the incident of knee fractures and the time taken for the patella to heal it is imperative to have studies which demonstrate the effectiveness of the procedure. Early mobilization is the key for every fracture fixation. (Movement is life, life is movement

Keywords

Tension Band Wiring, Olecranon, Patella, Malleoli

Introduction

INTRODUCTION

Fracture is a complete or incomplete break in bone by application of excessive force.[1] In this era, fracture of Patella, Olecranon and Medial malleoli are on an increasing note mainly resulting from road traffic accidents with lesser force of impact and hectic working schedule of a common man.

Patella is a largest sesamoid bone and embeded in the tendon of quadriceps femoris anterior to distal femoral condyles. Olecranon is the bone of elbow. It is the proximal extremity of the ulna which articulates with the distal humerus and forms part of the elbow joint. Medial malleolus is the slightly expanded medial portion of the distal end of the tibia. It projects inferomedially as the medial malleolus.[2]

Fractures of the eccentrically loaded bones like patella, olecranon, and medial malleolus are one of the most common fractures encountered by an orthopaedic surgeon. They continue to pose vexing problems as these being intraarticular and are being subjected to continuous deforming forces from muscles. It is also difficult to restore the desired anatomical continuity and congruity of their articular surfaces after reduction and thereby causing complications like osteoarthritis, stiffness of joints, nonunion etc. Hence, with better operative techniques, internal fixation of these fractures with tension band wiring for transverse fractures has become an accepted mode of treatment with its outcome results enabling the patient to smoothly resume his work without hampering his day-to-day life. Internal fixation of fractures speeds up the healing and rehabilitation. It also allows for early mobilization of the joint thereby preventing stiffness of joints and other complications related to immobilization.

Tension band is a principle and not a particular implant. This technique converts a tensile force into a compressive force. This improved the fracture healing, as stability is improved when tensile force is reduced at the fracture site. To apply an implant with a tension band technique, a device is fixed eccentrically to the convex side of the fractured bone. Since a curved structure has a compression side and a tension side when an axial load is applied, the device on tension side neutralizes the forces under an axial load. A tension band can produce compression statically or dynamically. Tension bands can enable immediate motion at the involved joints, which allows for an improved functional outcome.[3]

Aim of the Study

AIM OF THE STUDY

- To assess the functional outcome of tension band wiring in transverse fracture of Patella, Olecranon & Medial malleolus.

Review of Literature

REVIEW OF LITERATURE

OLECRANON

In the earlier days, Olecranon fractures were splinted in full extension for 4 to 6 weeks. This resulted in stiff elbow with loss of flexion and hence early practitioners began to use position of mid flexion, which led to non-union of olecranon due to separation of fragments.[5]

Rambold first published the use of fascial strip to repair displaced olecranonfractures.[6]

In 1933, Daland, presented the first substantial series of olecranon fractures.[7]

In 1952, Zuelger reported the use of hook plate for fixation fractures in which one small fracture was separated from principal part of the bone.[8]

Weber and Vasey (1963), Watson Jones (1976) suggested the use of two parallel intramedullary K-wires and the figure 8 loop of steel wire combining intramedullary and tension band principle.[9]

In 1969, Taylor and Schan described a modified method of screw fixation for fractures of olecranon[10]

Netz P, Stromberg L et al[11] (1982) concluded that by using a newly constructed 4 pin instead of Kirschner wires in the traction absorbing wire (TAW) technique, the clinically observed sliding of the Kirschner wires and resulting skin problems are avoided.

Holdsworth BJ, Mossad MM et al (1984) analyzed elbow function following tension band fixation of displaced fractures of the olecranon. The results confirmed that tension band fixation can yield excellent functional results whatever the degree and severity of fracture of the olecranon and the wires must be totally buried to allow full excursion of the triceps tendon.[12]

Jensen CM, Olsen BB (1986) studied the drawbacks of traction absorbing wiring (TAW) in displaced fractures of the olecranon observed in 29 out of 55 consecutive patients. Sliding of the K wires, with resulting skin troubles in 24 patients (10 patients with perforation of the skin), required premature removal of the implant. Minor operative modifications in the TAW technique are suggested in order to avoid these draw backs.[13]

Wolfgang reported good results in 29 out of 30 displaced olecranon fractures fixed with intramedullary K-wires and tension band wiring.[13] They noted wire migration in only two fractures. Larsen and Lyndrup found that wire migration was eliminated in their 21 patients by the use of pins with a hole at the base for insertion of the tension band wire.[14]

Mullett JH, Shannon F, Noel J, (2000) studied the effect of K-wire position on backing out of the wire in a group of 80 patients with closed transverse olecranon fractures with a minimum follow-up time of 9 months. The rate of wires backing out as seen on X-ray was three times greater in patients who had K-wires passed down the long axis of the ulna rather than across the anterior cortex as recommended by the AO group.[15] They also observed that there was a reduced rate of wire back-out when Kirschner wires were passed through the anterior cortex of the ulna rather than intramedullary during tension-band wiring of transverse fractures of the olecranon.

Finsen V, Lingaas PS, Storro S. et al (2000) studied 31 patients with tension band wiring in displaced olecranon fractures.[16] Anatomic reduction was achieved in 24 elbows that underwent AO tension band osteosynthesis of displaced olecranon fractures.

Murphy et al found that a long intramedullary 6.5 mm AO cancellous screw combined with a No. 16 figure of eight wire was significantly stronger than a screw or figure eight wire fixation alone.[17]

Karlsson MK, Hasserius R, Karlsson C (2002) compared tension-band and figure-of-eight wiring techniques for treatment of olecranon fractures.[18] Removal of the hardware was performed in 81% of the patients with tension-band wiring and in 43% of the patients with figure-of-eight wiring. The figure-of-eight technique can, therefore, be recommended, as it is associated with less frequent secondary procedures for hardware removal.[18]

Villanueva P, Osorio F, Commessatti, M, et al (2004) concluded that tension band wiring provided satisfactory results for the treatment of olecranon fractures in the presence of fracture communition, but worse results were obtained in the presence of elbow instability and fracture extension into the coronoid.[19]

Aslam N, Nair S, Ampat G, Willett K et al (2004) concluded that internal fixation of fractures of the olecranon results in good functional outcome.[20] Fixation with a plate is effective and produces good outcome even though selected for the more complex olecranon fractures. Patients who have tension band wiring more often require a second procedure for removal of symptomatic metal work.

Candal-Couto JJ, Williams et al (2005) studied that transcortical wires inserted in <30 degrees of ulnar angulation in the coronal plane to the medial ridge of the olecranon, impinged on the radial neck, supinator muscle, or biceps tendon.[21] This was avoided when the wires were inserted, with the forearm in supination, at 30 degrees of ulnar angulation. We recommend this technique to be adopted to avoid forearm rotation impairment.

Nowark TE et al in 2010 suggested that new designed interlocking nail system shows higher stability in comparison with multifilament tension band wiring after continous dynamic loading.[22]

Van linden SC et al in 2012 concluded that k wire position in tension band wiring technique affects stability of wires and long term outcome in surgical treatment of olecranon fractures instability of k wire after TBW is more common after intramedullary placement of k wire resulting in proximal migration of k wire and gap appearance.[23]

PATELLA

In late 1800, Malgaigne developed percutaneous bone clamp that held each fragment and did closed reduction with screw mechanism.[24] These percutaneous methods were abandoned because of pin track infections and joint sepsis. Sir Hector Cameron of Glasgow, Scotland, performed the first open reduction of patella fracture in 1877, using silver thread through drill holes to reconstruct the patella and stabilize it.[25]

Lister and Trendelenburg performed similar procedures in Germany.[26]

In 1937, Brooke, Watson Jones believed that patella inhibited the action of quadriceps and concluded that strength of knee was improved by patellectomy, which for many years became the treatment of choice.[27] This widely accepted treatment was questioned by many experimental and long-term clinical studies that ultimately disproved the claims.

Benjamin et al evaluated modified tension band wiring, Lotke wiring, Magnuson wiring and screw fixation alone and found the modified tension band technique to bebest fixation.[28]

In 1980, Weber MJ, Janecki, McLeod compared the efficiency of various forms of fixation of transverse fractures of patella using circumferential wiring, tension band wiring, Magnusson wiring and modified tension band wiring. They noted that the separation of fracture fragments was less with Magnusson wiring and modified tension band wiring.[29]

Hung LK, Chan KM, Chow YN, Leung PC et al (1985) concluded that minor troubles from the operations were common and wiring of fractured patella using the tension band principle is a safe and effective technique.[30]

Levack B, Flannagan JP, Hobbs S et al (1985) concluded that the best results should be treated by accurate reduction with tension band wiring.[31]

Curtis MJ et al (1990) compared modified AO tension band technique with the combination of cerclage wiring and tension band. The combination of cerclage and tension band wiring proved to be significantly stronger and is recommended.[32]

Hung LK, Lee SY, Leung KS et al (1993) concluded that partial patellectomy for patellar fracture with figure-of-eight tension band wire loop from the patella down to the tibial tubercle resulted in high percentage of osteoarthritis.[33]

Burvant JG, Thomas KA, Alexander R, et al (1994) tested five techniques of internal fixation of transverse patella fractures.[34] The tension band with screws technique performed significantly better than did the modified tension band, with an average fracture gap approximately half that of the traditional modified tension band technique. Mechanically, the addition of the screws to the tension band techniques reduces fracture separation by providing compression throughout the range of motion and by resisting the tensile loading during terminal extension.

Berg EE et al (1997) described that fixation technique for transverse patella fractures had clinical results equivalent to reports of patella fractures fixed with modified tension band wiring.[35] Advantages included a low-profile construct that caused lesser degrees of implant irritation to local soft tissue structures, was compatible with the use of early restricted motion, and afforded a method to salvage three cases in which traditional tension band wiring failed to maintain an anatomic reduction in osteoporotic bone.

Carpenter, James E, Kasman, Roberta A, Patel, Niraj, Lee, Michael L, Goldstein, Steven et al (1997) compared the mechanical effectiveness of three different techniques for stabilization of transverse fractures of the patella.[36] Combining interfragmentary screw fixation with the tension band principle appears to provide improved stability over the modified tension band or screws alone for transverse patella fractures. Cannulated screws allow for simple, reliable addition of a tension band to screw fixation.

Chatakondu SC, Abhaykumar S, Elliott DS et al (1998) described the use of a non-absorbable, braided, polyester suture, 5 Ti-Cron (Davis and Geck, Gosport, Hampshire), for the fixation of patellar fractures as an alternative to stainless steel wire. Seven patients had their fractures fixed with this material and all progress ed tounion with good restoration of knee function.[37]

Chen A, Hou C, Bao J, Guo Set al (1998) studied the use of biodegradable metallic tension band fixation for patella fractures. 38 patients were followed for 2 years and concluded that it can be used with no need for a second operation to remove the implants after bone union.[38]

Gosal HS, Singh P, Field RE et al (2001) studied patellar fracture fixation using metal wire and non-absorbable polyester in a study of 37 cases.[39] They concluded that the risk of infection in the metal group is higher. These have implication on patient morbidity associated with the operative treatment of patellar fractures. Non-absorbable polyester appears to compare favourably with the use of metallic wire to fix patellar fractures.

Yang KH, Byun et al (2003) evaluated the clinical effectiveness of the separate vertical wiring technique in acute comminuted fractures of the inferior pole of the patella.[40] All the fractures healed at a mean of seven weeks (6 to 10). No breakage of a wire or infection occurred. This technique preserved the length of the patella, fixed the comminuted fragments of the inferior pole and avoided long-term immobilization of the knee.

Gardner Michael J, Griffith, Matthew H, Lawrence, Brandon D, Lorich, Dean G et al (2005) concluded that anterior tension band fixation constructs are among the mainstay of treatment of patella fractures and lead to reliable results with simple transverse fracture patterns.[41]

Hughes SC in 2007 concluded that a new and effective tension band braided polyester suture technique for transverse patella fixation causes less complication compare to stainless steel wire.[42]

Chiang CC, Chen W Min 2011 concluded that arthroscopic assisted percutaneous osteosynthesis of displaced transverse patella fractures with figure of eight wiring through paired cannulated screw suggested that it is safe and reproducible method for transverse patella fracture and not incicated for severely comminuted fracture.[43]

Jabshetty on a comparative study of modified tension brand wiring and cerclage wiring in management of transverse fractures of patellain Karnataka, India .Union was achieved in all 20 cases results were compared by using modified Bostman scale. Quadriceps wasting were seen in all 20 cases but it was minimal in group-A treated with modified tension band wiring may because of shorter period of immobilization. It was found that the results of all the cases were comparable but cases treated with modified tension band wiring showed better results as compared to cerclage wiring as the stability of implant is better and post operative rehabilitation is faster. Compound grade-I fractures of patella shows good results when treated by internal fixation.[44]

Rathi A, Swamy MK in 2012 concluded that percutaneous tension band wiring is viable option for transverse patella fractures.[45]

Hoshino CM ,Tran W in 2013 evaluated the complications following tension band fixation of patellar fractures with cannulated screws compared with k wires and concluded that symptomatic implants was the most common complication observed, were twice as frequent in patients treated with k wires.[46]

Della Rocca GJ in 2013 concluded that displaced patella fractures often result in disruption of the extensor mechanism of the knee. An intact extensor mechanism is a requirement for unassisted gait. Therefore, operative treatment of the displaced patella fracture is generally recommended. The evaluation of the patella fracture patient includes examination of extensor mechanism integrity.[47] Operative management of patella fractures normally includes open reduction with internal fixation, although partial patellectomy is occasionally performed, with advancement of quadriceps tendon or patellar ligament to the fracture bed. Open reduction with internal fixation has historically been performed utilizing anterior tension band wiring, although comminution of the fracture occasionally makes this fixation construct inadequate.

A study done by Jin Ho Cho on Percutaneous Cannulated Screws with Tension band Wiring Technique in Patella Fractures in Korea, the results shows: all cases were gained complete bone union. Radiographic bone union period were 7.3 weeks (range, 6 to 11 weeks). ROM of knee was flexion contracture 2° (range, 0° to 5°) and further flexion were 133° (range, 125° to 135°). Lysholm knee score were 93 (range, 85 to 97). We have no complications like limitation of knee motion, loss of reduction, failure or migration of hardware and infection at last follow up.[48]

Siddaram NP illustrated a Prospective Clinical Study of Patellar Fractures Treated by Modified Tension Band Wiring in Andra Pradesh, India:

In this series the range of age was between 14-72 years, the mean age was 42.05 years and the incidence was high in the age group of 41-50 years. 22 fractures were in men and 8 fractures were in females. 20 fractures were as a result of indirect mechanism and 10 cases were due to direct trauma to the patella as in Road traffic accident. 17 patients had fracture on the right side and 13 patients had fracture on the left side. Based on WEST'S Criteria our results were graded as excellent in 26 cases (86.6%), good in 3 cases(10%) and poor in 1 case (3.3%).[49]

Comparison to TBW with the cable pin system in patella Fracture A randomized prospective study Tan Qx, Haiy, RuXR (2015) concluded that cable pin system is a viable options for transverse Fracture of patella with shorter healing time and fewer complications and better function than TBW.[50]

ANKLE INJURIES:

Hippocrates discussed ankle fractures in about 300 BC. It was Pott in 18th century who really attempted to describe pathological findings.

Dupytren was first to use experimental method in the study of ankle injuries, producing fractures in cadavers. He emphasized the role of abduction and position of foot while the injury takes place.

In 1943, Le and Horen reported that soft inert position was a major problem and hence recommended primary open reduction.

In 1964, Carl Axel Cadel concluded that secondary osteoarthritis and instability was common after open reduction with repair of ligaments.

In 1970, a number of anatomical, biomechanical and clinical studies combined to show the importance of exact restoration of ankle joint including both medial and lateral malleolus.

In 1972, Denis Weber classified ankle injuries into three types according to the level of fibular fractures.

In 1992 Ostrum R.F, Litsky AS tension band fixation of medial malleoli is a biomechanically strong and clinically acceptable method of treatment for displaced medial malleoli fractures. This method of fixation may be especially use for small fragment and in osteoporotic bone.[51]

Bucholz, Robert W, Phen, Henley M. Bradford et al (1994) studied fixation with bioabsorbable screws for the treatment of fractures of the ankle.[52] One hundred and fifty-five patients who had a closed, displaced medial malleolar, bimalleolar, or trimalleolar fracture of the ankle were managed with medial malleolar fixation with use of either 4.0-millimeter polylactide screws. They concluded that polylactide screws are a safe and effective alternative to stainless steel screws for the fixation of displaced medial malleolar fractures.

Georgiadis GM and White DB described in 1995 modified tension band wiring of medial malleolar fractures. The technique involves use screw to anchor the figure of 8 wires.[53]

Michelson JD in 2003 conclude that ankle fracture with syndesmotic injury have additional tibio fibular instability that can be controlled by screw fixation.[54]

Kenneth A. Egol, Nirmal Tejwani in 2005 studied ankle stress test for predicting the need for surgical fixation of isolated fibular fractures.[55]

TY Fowler and Kevin pugh in 2011 concluded that tension band fixation using stainless steel wire was statistically stiffer than fibre wire construct.[56]

Ricci WM in 2012 concluded that screw placed with lag by method technique that engage the distal lateral tibia cortex have superior biomechanical clinical and radiographical outcome compared to partial threaded screw for the fixation of medial malleoli fractures.[57]

PRINCIPLES OF TENSION BAND WIRING

Introduction

The tension band technique converts a tensile force into a compressive force. This enables improved fracture healing, as stability is improved when tensile forces are reduced at the fracture site. Tension banding is particularly useful in the setting of fractures where a muscle pull produces distraction of the fracture fragments, such as fractures of the patella, olecrenon, greater tuberosity of the humerus, or greater trochanter of the femur. Tension bands can enable immediate motion at the involved joint, which allows for an improved functional outcome.

Biomechanic principles

Tension banding is a principle and not a particular implant. To apply an implant with a tension band technique, a device is fixed eccentrically to the convex side of the fractured bone. Since a curved structure has a compression side and a tension side when an axial load is applied, the device on tension side neutralizes the forces under an axial load. The essential prerequisite is there must be cortical contact on the compressive side, which is the side opposite to the implant. If there is a cortical defect or comminution on the compressive side, the implant will undergo bending stress and be subjected to early fatigue failure.

A tension band can produce compression statically or dynamically. If a tension band produces fairly constant force at the fracture site during motion, such as at the medial malleolus, it is called a static tension band. Conversely, if the compression increases with motion, such as in the patella with knee flexion, the tension band is called dynamic.

Key concepts

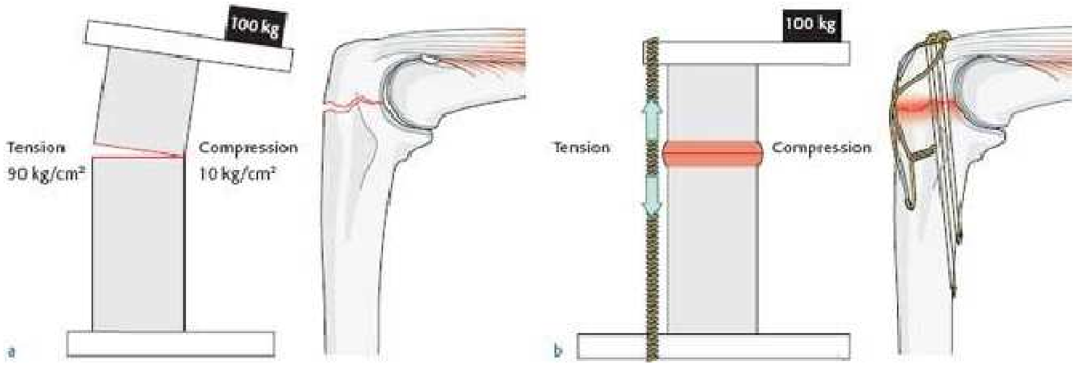
The following prerequisites are essential:

1. There must be intact cortical contact on the side opposite the tension band.
2. The fixation must be able to withstand tensile force.
3. The bone or fracture pattern must be able to withstand compressive force.

Advantages of Tension Band Wiring

It is inexpensive and effective method of internal fixation. Less cumbersome good patient compliance, early mobilization of the joint is possible.

Maintains the approximate continuity of the bone without affecting the healing process even after the joint is mobilized.



Tension band principle

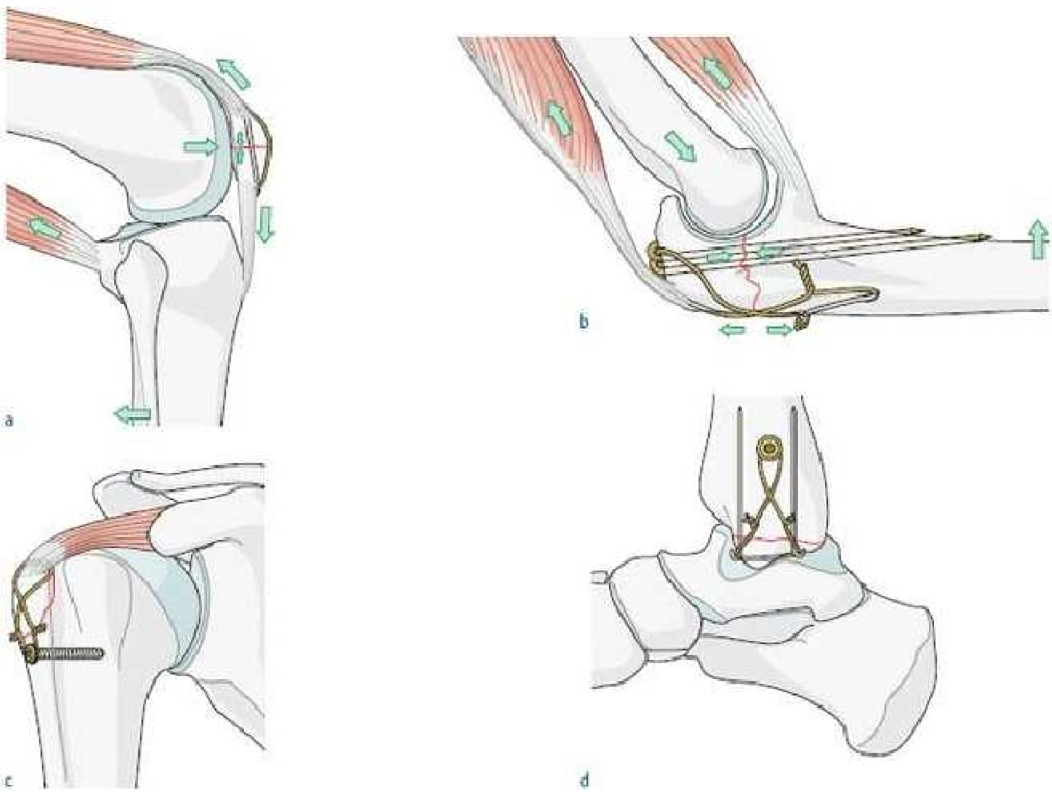


Fig 1. Tension band applied at various sites

ANATOMY

OLECRANON

The olecranon process is a large curved eminence comprising the proximal and posterior portions of the ulna. It lies in a subcutaneous position, which makes it especially vulnerable to direct trauma. Together with the proximal portion of the coronoid process, the olecranon forms the greater sigmoid (semilunar) notch of the ulna, a deep depression that serves as the articulation with the trochlea, which allows motion only in the anteroposterior plane and provides stability to the elbow joint. The articular cartilage surface is interrupted by a transverse line of bone, "a bare area", located midway between the tip of the olecranon and the coronoid process. If this is not recognized during reconstruction of the fractured olecranon, there is a temptation to eliminate any area uncovered by cartilage.

The ossification center for the olecranon appears at 10 years of age and is generally fused to the proximal ulna by the age of 16. There are reports of persistent physes in adults; these are usually bilateral and tend to occur in families.

This is not to be confused with patella cubiti, which is a true accessory ossicle located in the triceps tendon at its insertion into the olecranon. Both of these entities may be confused with a fracture, especially if there has been local trauma. A comparison film may be helpful and prevent unneeded treatment.

Posteriorly, the triceps tendon covers the joint capsule before it inserts into the olecranon. The fascia overlying the triceps muscle spreads out medially and laterallylike the retinaculum of the quadriceps in the knee. These expansions and the triceps aponeurosis insert into the deep fascia of the forearm and into the periosteum of the olecranon and proximal ulna.

Nerve supply of elbow

The humeroulnar and humeroradial articulations of the elbow joint are served by the musculocutaneous, radial, and ulnar nerves. Anteriorly, the lateral aspect of the elbow joint is covered by the C6 dermatome; the more medial area is covered by the C5 and T1 dermatomes; and, finally, the medial aspect is covered by the C8 dermatome. Posteriorly, the C6 dermatome laterally and the C8 dermatome medially are split down the middle by the C7 dermatome.

The inferior lateral cutaneous nerve of the arm and the posterior cutaneous nerve of the forearm are the sensory nerves of the lateral elbow. The medial cutaneous nerve of the forearm, via its ulnar (posterior) and anterior branches, supplies sensation to the medial aspect of the elbow. Across the anterior aspect of the elbow, in the cubital fossa, the sensory branch of the musculocutaneous nerve (the lateral cutaneous nerve of the forearm) supplies sensation.

Crossing the elbow joint anteriorly is the median nerve. Just proximal to the joint, it gives off a branch to the pronator teres, where the muscle originates at the medial epicondyle; just distal to the joint, it gives off branches to the Palmaris longus (if present), to the flexor carpi radialis, and again to the pronator teres before continuing down the forearm.

The ulnar nerve travels medially down the arm to pass posterior to the elbow joint in a groove at the posterior aspect of the medial epicondyle, known as the cubital tunnel; it then gives off branches to the flexor carpi ulnaris and the medial half of the flexor digitorum profundus just distal to the joint before continuing down the forearm.

The radial nerve is an interesting case. Passing from the posterior as it leaves the radial groove laterally in the arm, perishes lateral intermuscular septum and comes to anterior side of the arm. It gives off branches to the brachioradialis and the extensor carpi radialis longus before splitting into the superficial and deep branches proximal to the elbow joint and then traveling anterior to the elbow joint.

The superficial branch of the radial nerve continues primarily as a sensory branch. The deep branch gives off innervation to the extensor carpi radialis brevis and then crosses the elbow joint anterior to the lateral epicondyle of the humerus. It continues down the forearm as the posterior interosseous nerve after piercing the supinator muscle, which it innervates, and moves posteriorly again to pass down the posterior of the forearm.[5] Supplies all the extenses of wrist and finger.

Blood supply

The blood supply to all the articulations of the elbow joint comes via local branches from the periarticular arterial anastomoses of the elbow region.[6] The brachial artery gives off the superior and inferior ulnar collateral arteries (which generally anastomose with each other as well), and the deep artery of the arm continues and splits into the radial collateral and middle collateral arteries. After crossing the elbow joint in the cubital fossa, the brachial artery splits into the ulnar and radial arteries. The ulnar artery gives rise to both the anterior ulnar recurrent artery, which joins the inferior ulnar collateral anterior to the medial epicondyle of the humerus, and the posterior ulnar recurrent artery, which joins the superior ulnar collateral artery posterior to the medial humeral epicondyle.

The radial artery gives off the radial recurrent artery, which joins with the radial recurrent branch of the deep artery of the arm anterior to the lateral epicondyle. The middle collateral branch of the deep artery of the arm splits posterior to the elbow joint. One branch of this artery passes inferiorly across the elbow to join with the recurrent interosseous artery off the ulnar artery; the other crosses the elbow horizontally just proximal to the joint and joins the superior ulnar and posterior ulnar arterial anastomoses.

Range of movements: flexion 0-135^{o}, extension 0-5^{o}, supination 0-85^{o}, pronation 0-75^{o}.

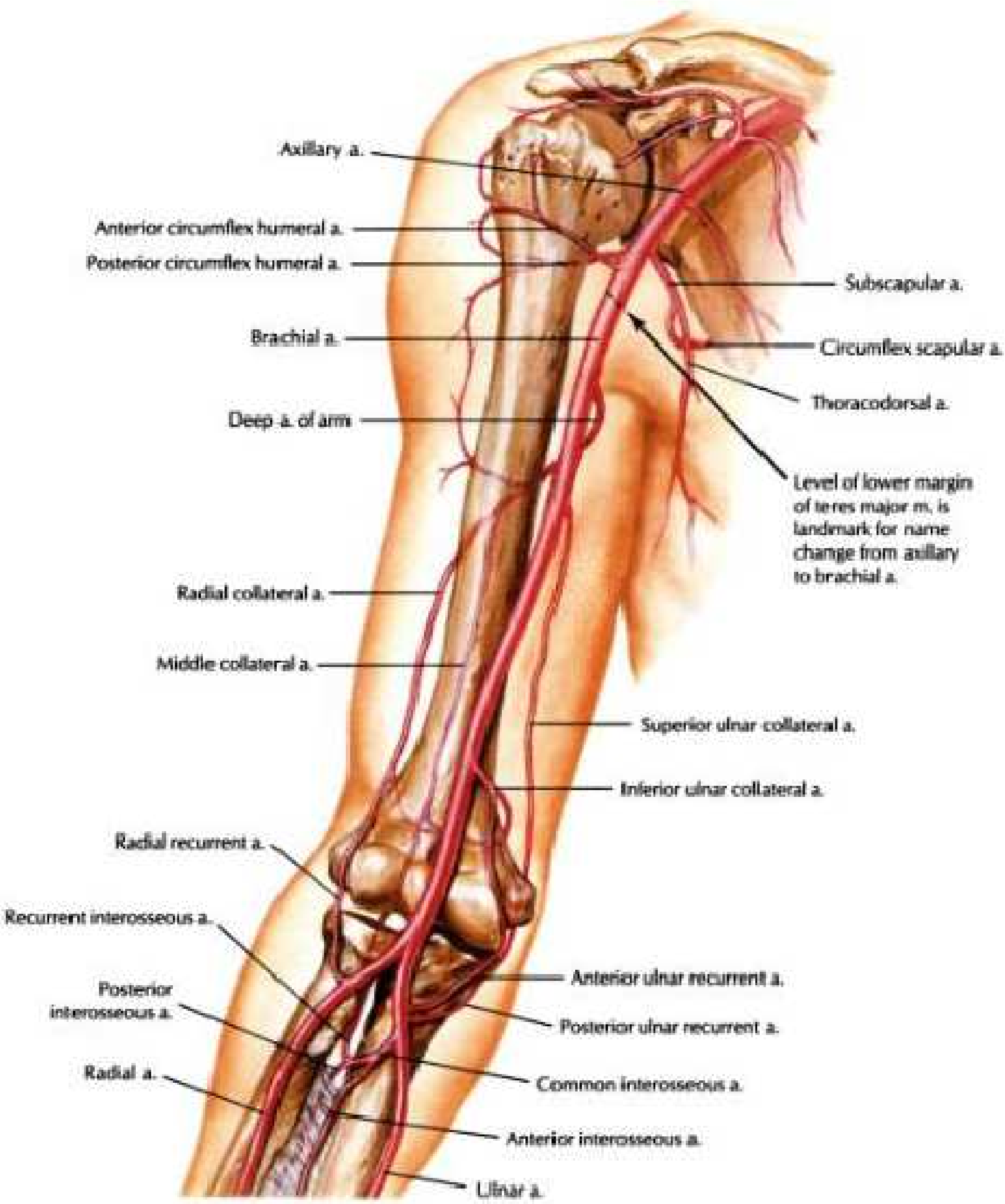


Fig 2. Blood supply of elbow joint

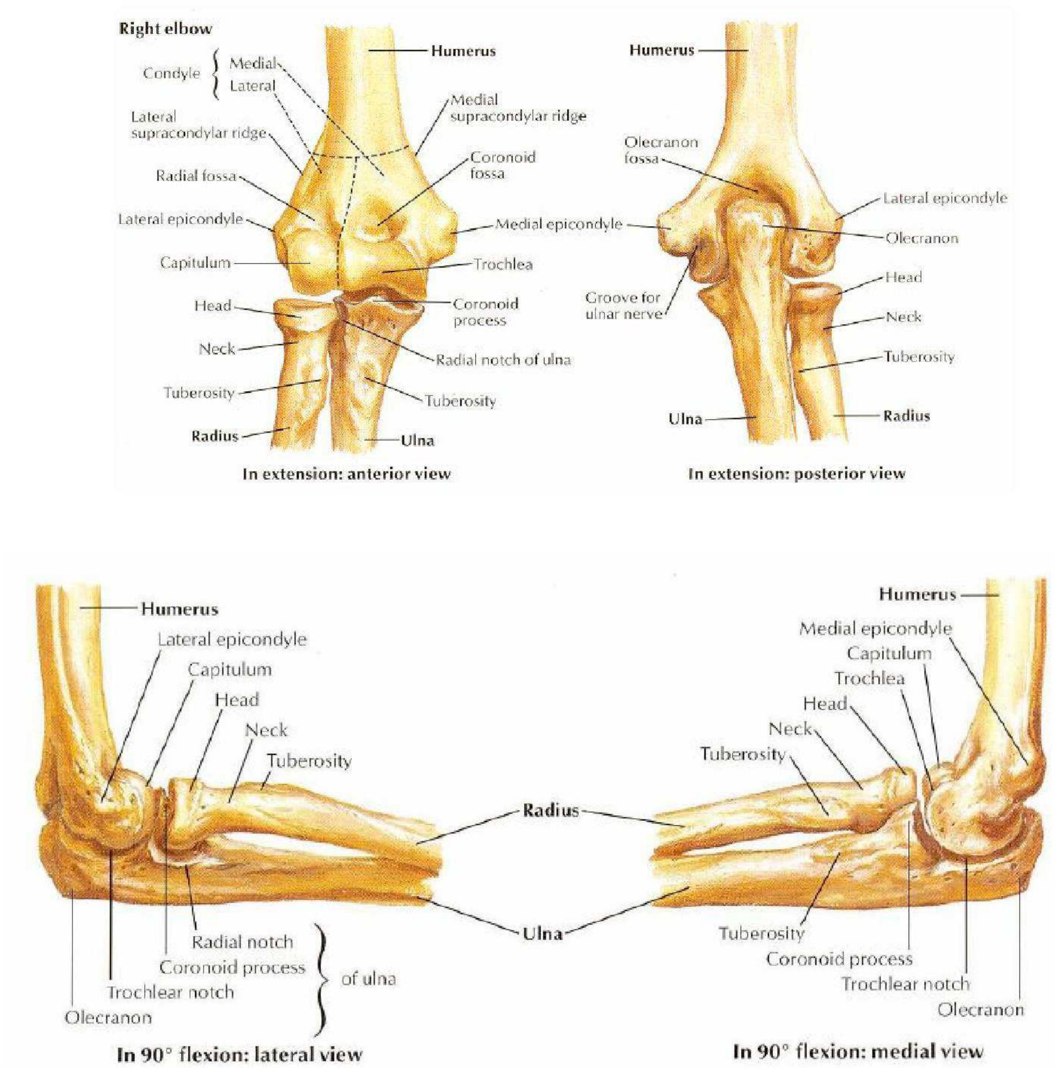


Fig 3. Anatomy of the elbow

PATELLA

The patella is the largest sesamoid bone in the body and lies within the quadriceps tendon. The ossification center usually appears at 2 to 3 years of age, but its appearance may be delayed until as late as 6 years. Anomalies of ossification usually are related to an accessory ossification center located at the superolateral corner of the patella. This is called the bipartite patella. If a similar lesion is present on the radiograph of the opposite knee, the diagnosis is clear. If not, special radiographic views, including CT, may be necessary to differentiate it from nonunion of a patellar fracture. Stress fractures of the patella may be difficult to diagnosis and are often seen in osteopenic elderly patients complaining of anterior knee pain after minor trauma. Bone scanning of the patella several days after injury may reveal "hot areas" corresponding to the patient's symptoms and confirming the diagnosis.

The patella is triangular with the apex directed distally. The proximal patellar pole is broad and thick and receives the insertion of the rectus femoris and vastus muscles (lateralis, medialis, and intermedius). Most of the quadriceps aponeurosis inserts into the superior pole of the patella. The medial and lateral margins of the patella receive fibers from the vastus medialis and lateralis, respectively. The distal pole or apex provides the origin of the patellar tendon, which inserts into the tibial tubercle. A thin layer of quadriceps tendon associated with thick Sharpey's fibers passes over the anterior surface of the patella, joining the patellar tendon distally.

Theposterior three-fourths of the patella is covered by articular cartilage and is divided into major medial and lateral facets that articulate with the anterior trochlea of the distal femur.

The blood supply to the patella is formed by an extraosseus anastomotic ring within the loose connective tissue lying over the extensor mechanism connective tissue. There are several vessels that contribute to this anastomotic ring, including a central superior geniculate vessel, medial and lateral superior and inferior geniculate vessels, and an inferior recurrent tibia vessel. The primary blood supply of the patella enters the bone by way of the anastomotic vessels through the middle of the anterior portion of the body of the patella and through the distal pole vessels. This relationship is important in understanding the mechanism of avascular necrosis as a sequela of patellar fractures. Fractures through the midportion of the patella, especially transverse fractures with displacement, interrupt the main nutrient arteries ascending from the central portion of the patella and leave the proximal pole and, to a lesser degree, the central portion of the patella at risk for avascular necrosis. The inferior pole tolerates this vascular insult letter because of the dual blood supply originating from the midpatellar and inferior pole vessels that remain intact after transverse fractures. The incidence of avascular necrosis has been reported to range from 3.5% to 24%. Avascular necrosis may develop after conservative treatment but is more often seen after internal stabilization of fractures treated with circumferential repair that occludesperipatellar vessel blood supply. Avascular necrosis is frequently diagnosed within 1 to 2 months after fracture with radiographic evidence of sclerosis of either the proximal or the distal pole fragment. The presence of avascular necrosis does not dramatically affect patellar function immediately. Healing of the fracture will usually occur if appropriate fixation is applied. Scapinelli reported a series of 41 cases of avascular necrosis of the patella with no significant loss of function and some degree of patellofemoral arthritis many years after fracture. It was often the practice in the past to excise either superior or inferior pole patellar fragments because of the potential for avascular necrosis or the likelihood of obtaining an anatomical reduction with stable internal fixation was deemed too difficult. In light of the lack of significant residual sequelae after repair of patellar fractures, the practice of routinely resecting major fragments or polar fragments is to be condemned in favor of anatomical reconstruction of the patella and preservation of the extensor mechanism whenever possible.

Biomechanics of patella:

The functions of the patella are to increase the mechanical advantage of the quadriceps tendon, aid in nourishment of the anterior articular surface of the femur, and protect the femoral condyles from injury. The patella transmits the tensile forces of the quadriceps muscle to the patellar tendon. The patella improves the efficiency of the quadriceps muscle by elevating the extensor mechanism from the axis of rotation of theknee joint. It also increases the leverage of the quadriceps muscle by making it act over a greater angle. Daily activities generate patellofemoral compressive forces of greater than three times body weight, while forces generated with stair climbing and deep squatting may exceed seven times body weight. Tensile forces across the patella may reach 3000 N and may increase to 6000 N in athletes. Several authors have estimated patellofemoral contact stresses of 2 to 10 N/mm2, nearly double the estimated tibiofemoral contact stresses of 2 to 5 N/mm2. These estimates provide evidence for the importance of maintaining anatomical articular reduction and rehabilitation of the knee after patellar fracture to maximize stress distribution across the patella femoral joint.

The patellar cartilage articulates with the anterior surface of the femoral condyles. The area of contact between the patella and the femur varies according to the position of the knee. With the knee extended, the lower portion of the patella is in contact with the femur. Increasing knee flexion brings first the middle and then the upper portion of the patella into contact with the anterior femoral condyle. The posterior articular surface of the patella is divided by a vertical ridge into two major surfaces, the medial and lateral facets. This ridge articulates with the anterior distal femoral articular groove. Inferior to the patellar articular surface is a rough nonarticular area, the distal pole. This portion of the patella provides the attachment of the patellar tendon.

The medial and lateral extensor retinacula, or "expansions," are composed of longitudinal fibers of the vastus medialis and vastus lateralis. The vastus lateralis combines with fibers of the fascialata that bypass the patella and insert directly intothe upper tibia at Gerdy's tubercle. Preservation of these medial and lateral expansions along with intact anterior fascia and Sharpey's fibers allows active extension of the knee after patellar fracture. This is an important fact in both diagnosis and treatment.

Blood supply of knee joint:

There is a complex anastomosis around the patella and condyles of tibia and femur. This anastomosis consists of a superficial network and a deep network. The superficial network spreads between the fascia and the skin around patella. It also supplies the fat deep to patellar tendon. The deep network lies on the femur and tibia near the adjoining articular surfaces, and supplies the bone, the joint capsule, synovial membrane and the cruciate ligaments. The arteries involved are superior, middle and inferior genicular branches of popliteal artery, descending genicular branches of femoral artery, lateral circumflex femoral artery and the circumflex fibular artery. The venous drainage corresponds in name to the arterial supply and runs with it. The smaller veins eventually drain into the femoral and popliteal veins.

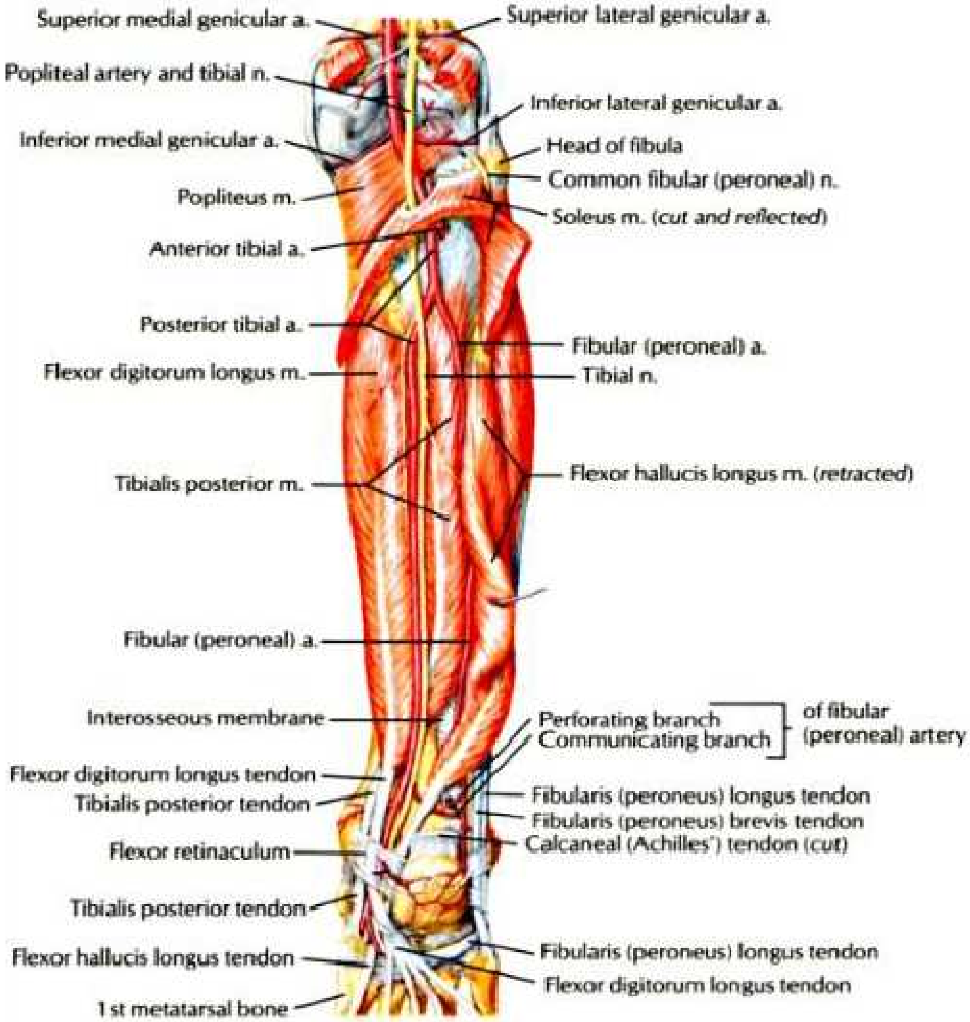


Fig 4. Blood supply of knee joint

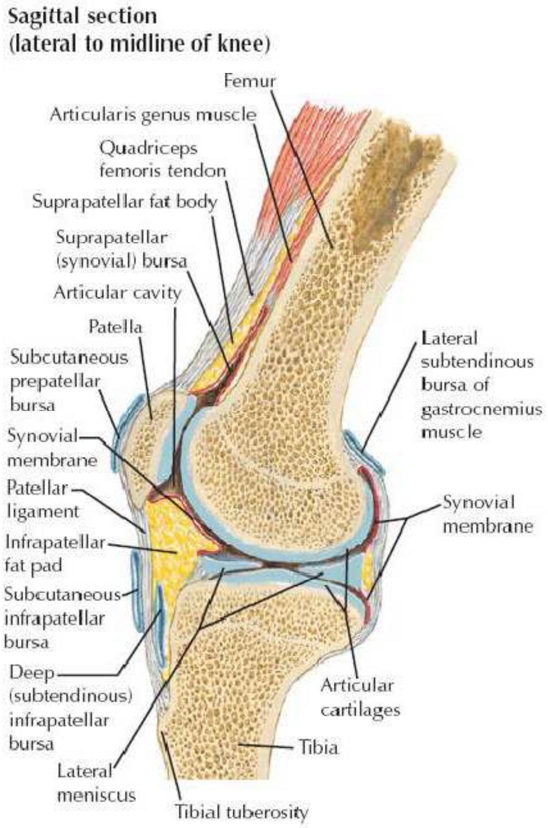
Lymphatic drainage of Knee joint:

The lymphatic drainage of knee joint is to popliteal nodes. Most of the lymph vessels accompany the genicular arteries. The popliteal nodes drain into the inguinal group of lymph nodes.

Nerve Supply to knee joint:

The knee joint receives its nerve supply from branches of the obturator, femoral, tibial and common peroneal nerve

Range of movements: flexion 0-135^o ,extension 0-5^o



Anatomy of knee

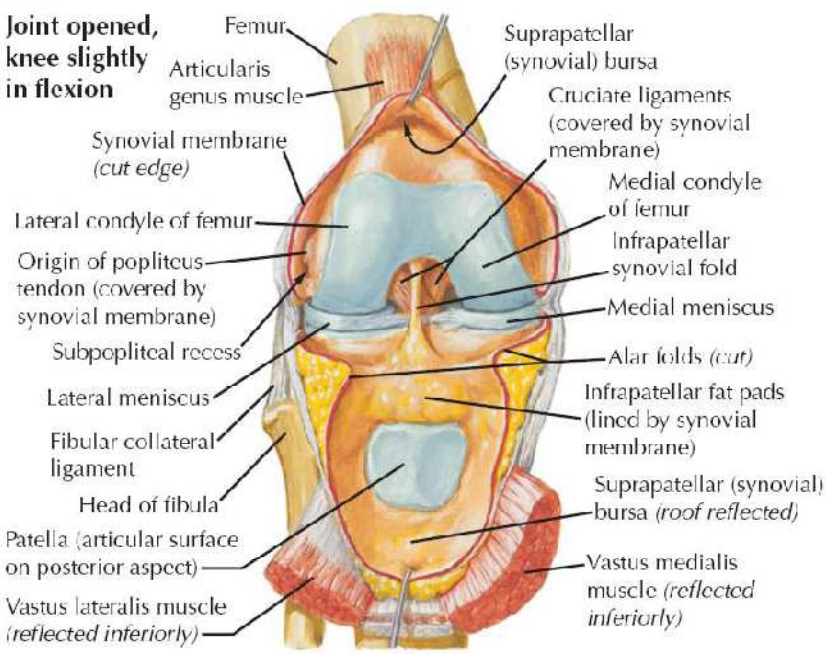


Fig 5. Anatomy of knee

ANKLE JOINT

The ankle is a complex joint consisting of functional articulations between the tibia and fibula, tibia and talus, and the fibula and talus, each supported by a group of ligaments. The tibia and fibula form a mortise, providing a constrained articulation for the talus . The articular surface of the distal tibia (tibial plafond) and the mortise is wider superiorly and anteriorly to accommodate the wedge-shaped talus. The shape of the joint alone provides some intrinsic stability, especially in weight bearing.

Bone:

The medial malleolus is an extension of the distal tibia. The inner surface is covered with articular cartilage and articulates with the medial facet of the talus. The distal, inner surface of the malleolus is divided by a longitudinal groove into a large, anterior colliculus and a smaller, posterior colliculus, each an attachment site for a portion of the deltoid ligament. There is also a groove on the posterior surface where
the posterior tibial tendon passes behind the malleolus and the tendon sheath is attached.

The fibula provides the lateral support of the ankle. Just above the ankle joint, the fibula sits in a groove formed by a broad anterior tubercle and a smaller posterior tubercle of the tibia. There is no articular surface between the distal tibia and fibulaeven though there is a small amount of motion between these two bones. The medial border of the fibula is covered by articular cartilage from the level of the tibial plafond to a point approximately halfway down its remaining length. The distal end is tapered and has a posterior groove for the peroneal tendon.

The talus has a curved head, an intermediate neck portion, and a large trapezoidal body. It articulates with the navicular, calcaneus, tibia, and fibula. The body of the talus is almost entirely covered by articular cartilage. The superior surface is convex from front to back and slightly concave from side to side. The dome of the talus is trapezoidal, and its anterior surface is an average of 2.5 mm (range, 0 to 6 mm) wider than the posterior surface. The articular surfaces of the malleoli are also wider anteriorly and support the talus. The medial and lateral articular facets of the talus are continuous with the superior articular surface, and the lateral facet is larger than the corresponding facet on the fibula. The majority of the talar neck has no articular surface and serves as the site of access for much of the blood supply to the rest of the talus. The multiple articular facets and lack of muscular attachments are evidence of the intercalary role of the talus in connecting the leg to the foot.

Ligaments:

Stability of the ankle joint is due to a combination of the bony architecture, the joint capsule, and the ligaments. Three distinct groups of ligaments support the ankle joint: the syndesmotic, medial collateral, and lateral collateral ligaments.

The syndesmotic ligament complex maintains the integrity between the distal tibia and the fibula and resists the axial, rotational, and translational forces that attempt to separate these two bones. It is made up of four ligaments: (1) the anterior tibiofibular ligament, (2) the posterior tibiofibular ligament, (3) the transverse tibiofibular ligament, and (4) the interosseous ligament.

The anterior tibiofibular ligament originates on the anterior tubercle and anterolateral surface of the tibia and runs obliquely to the anterior fibula. The posterior tibiofibular ligament originates on the posterolateral tubercle of the tibia and inserts on the posterior fibula. It is stronger and thicker than its anterior counterpart.

Because of this difference, torsional or translational forces usually cause an avulsion fracture of the posterior tibial tubercle, leaving the posterior ligament intact, while the weaker anterior tibiofibular ligament usually ruptures.

The transverse tibiofibular ligament is often considered part of the posterior tibiofibular ligament complex and acts to deepen the posterior aspect of the ankle joint. The interosseous ligament is an extension of the interosseous membrane and is the key transverse stabilizer of the tibiofibular articulation. The ligament is triangular with aproximal apex and a broad distal base and is thinner in its midportion because of a perforating synovial pouch from the ankle joint. The interosseous membrane runs between the tibia and fibula to the level of the proximal tibiofibular joint. It stabilizes the fibula, provides additional attachment sites for muscles, and may have some loadbearing function.

The medial ligamentous support of the ankle is provided by the superficial and deep deltoid ligaments. The superficial deltoid ligament originates primarily from the anterior colliculus of the medial malleolus and extends in three bands to the navicular and along the plantar calcaneonavicular (spring) ligament, to the sustentaculum tali of the calcaneus, and to the medial tubercle of the talus. The tibionavicular portion suspends the spring ligament and prevents inward displacement of the head of the talus, while the tibiocalcaneal portion prevents valgus displacement. The superficial deltoid is also partially covered by tendon sheaths and crural fascia.

The deep deltoid ligament originates on the posterior border of the anterior colliculus, the intercollicular groove, and the posterior colliculus. It is oriented transversely and inserts into the entire non-articular surface of the medial talus. The deep deltoid extends the function of the medial malleolus and prevents lateral displacement of the talus.

The fibular collateral ligament is made up of three separate structures. They are not as strong as the medial ligaments, because lateral support for the ankle is also provided by the fibula.

The anterior talofibular ligament is the weakest of these ligaments. It connects the anterior fibula to the neck of the talus and prevents anterior subluxation of the talus when the ankle is in plantar flexion. The midportion of this ligament is confluent with the capsule of the ankle. This area overlies a ridge formed by the anterior border of the lateral articular facet of the talus and may be injured by this ridge with the ankle in a plantarflexed position.

The calcaneofibular ligament connects the distal fibula to a small tubercle on the posterior and lateral aspect of the calcaneus. This ligament is not associated with either the ankle capsule or the peroneal tendon sheath. It is lax in the normal, standing position, owing to the relative valgus orientation of the calcaneus. It acts primarily to stabilize the subtalar joint and limit inversion.

The posterior talofibular ligament arises from the non-articular surface of the posteromedial fibula and inserts onto the lateral tubercle of the talus. It is the strongest of the lateral ligaments and prevents posterior and rotatory subluxation of the talus.

Blood supply of ankle joint:

The ankle joint receives its blood supply form malleolar rami of the anterior and posterior tibial and peroneal arteries.

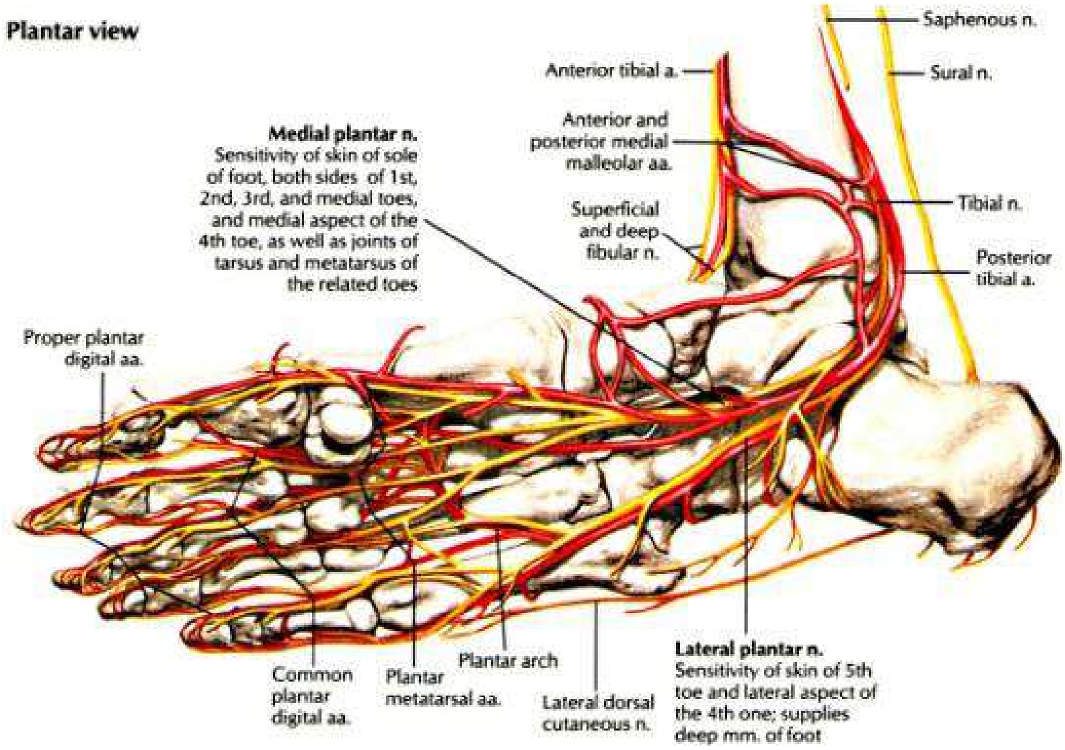


Fig 6. Blood and nerve supply of ankle joint

Lymphatic drainage of ankle joint:

Lymphatic drainage is through the vessels accompanying the arteries.

Nerve supply to ankle joint:

The ankle joint receives its nerve supply from deep peroneal, saphenous, sural and tibial nerves. Occasionally, the superficial peroneal nerve also supplies the ankle joint.

Movements of ankle joint:

As stated above, the ankle joint is a uniaxial hinge joint permitting only two types of movements: Dorsiflexion and Plantal flexion. The movements of inversion and eversion of foot seem to occur and ankle but actually they take place at the tarsal joints.

- Dorsiflexion:(0-20^{o})
- Plantar flexion:(0-50^{o})
- Subtalar inversion(0-5^{o})
- Subtalar eversion (0-5^{o})

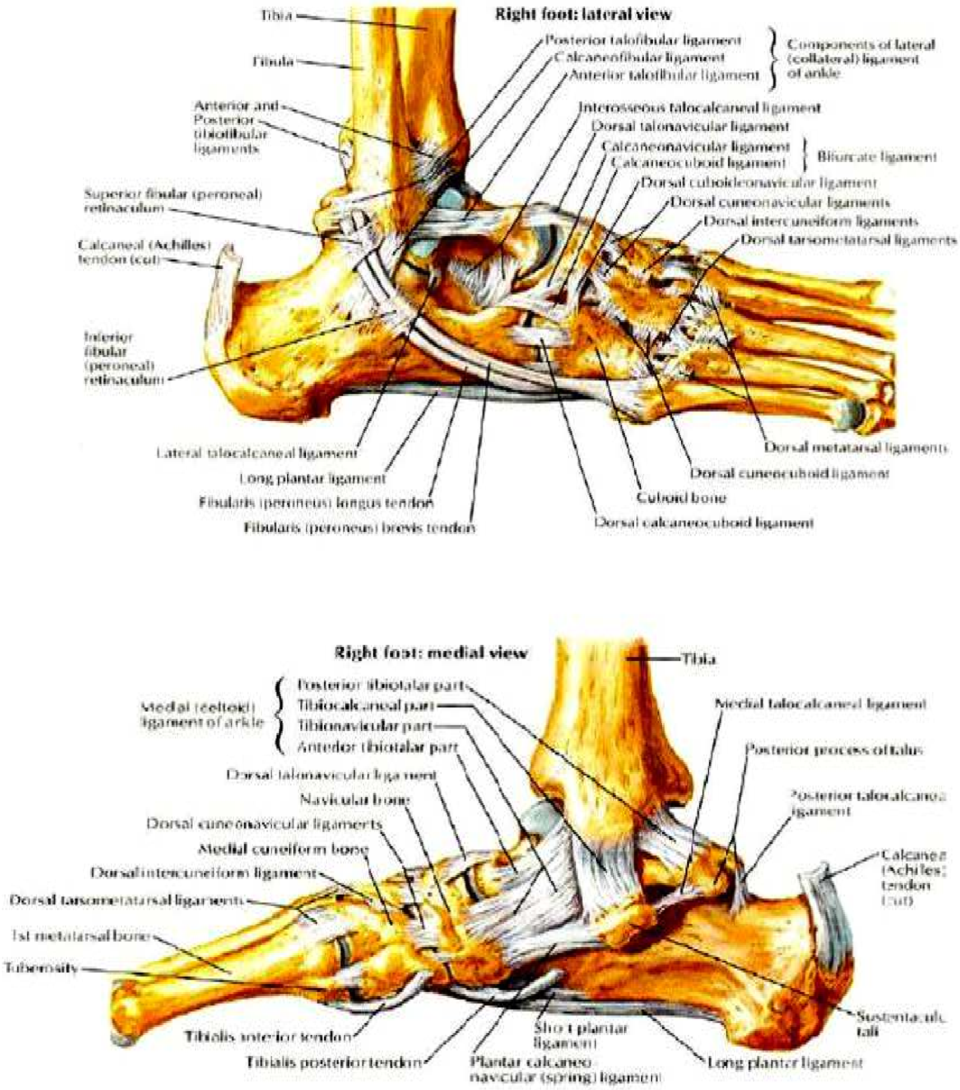


Fig. 7. Anatomy of Ankle

MECHANISM OF INJURY

OLECRANON FRACTURE

Mechanism of olecranon fractures:

Fractures of olecranon may be caused by direct or indirect trauma. A fall or a blunt trauma on the posterior tip of the elbow may cause fracture directly.

Indirect avulsion of olecranon by forces generated within triceps muscle may occur during a fall in a partially flexed elbow.

Signs and symptoms:

Because all fractures of olecranon have some intraarticular component, there is generally a haemorrhagic effusion of elbow joint, which results in pain, swelling over the olecranon. There may be a palpable sulcus at the fracture site with limited range of motion. Inability to extend the elbow against gravity is the most important sign, which indicates discontinuity of triceps mechanism.

Radiographic findings:

A lateral and AP x-ray of the elbow shows extent of the fracture, the degree of comminution, the amount of disruption of articular surface and fracture of the head of radius or neck fracture.

PATELLAR FRACTURES

Mechanism of injury:

Patella fractures account for 1% of all skeletal fractures and seen in age of 20 to 50 years. Incidence in men is almost twice that in women. Patella fractures result from direct or indirect forces.

Majority occurs from direct injuries such as blow to the patella from a fall, motor vehicle crash. Indirect injuries occur from a near fall, fall from a height or combination. This type of injury occurs when the forces from extensor mechanism exceeds the intrinsic strength of patella.

Once bony failure occurs, the injury may continue through the medial and lateral expansions of quadriceps by the pull of the muscle. This injury usually results in a transverse fracture with some inferior pole comminution and fragment displacement is dependent on the amount of damage to the quadriceps retinaculum.

Transverse fractures result from excessive longitudinal forces. Stellate fractures are caused by high-energy direct blow to the patella.

Table 1: Incidence of Patella fracture

Transverse fractures	50 - 80%
Stellate and comminuted fractures	30 - 35%
Longitudinal fractures	12 - 17%

Signs and symptoms:

Patients present with pain, swelling and decreased strength of the knee. Palpation reveals tenderness, gap between the fracture fragment segments. Abrasion, contusion over the knee should be examined for communication with knee joint by saline test as open patella fracture is a surgical emergency and requires debridement within 6 to 8 hours.

Damage to the extensor mechanism is tested by active knee extension.

Injection of local anesthetic into the joint can eliminate the pain and facilitate the performance of test.

Full active extension against gravity only indicates an intact extensor mechanism and does not rule out presence of fracture.

Radiographic evaluation:

Antero-posterior, lateral, axial (skyline) views are routinely used in the evaluation of patellar fractures.

AP radiographs may be difficult to evaluate due to secondary superimposition of distal femoral condyles.

Lateral views provide fracture displacement, patellar position and congruity of articular surface.

A low riding patella or patella Baja may indicate rupture of quadriceps tendon. A high riding patella or patella Alta may be a sign of patellar tendon rupture.

The position of patella is assessed using the ratio of greatest diagonal patellar length to patellar tendon length. Normally the ratio is 1. The ratio is less than 0.8 suggest high riding patella or patellar tendon rupture. The patella should lie in the middle of femoral sulcus.

In AP view the inferior pole or patella should lie within 2 cms of a plane formed by distal femoral condyles.

In lateral view, the proximal pole of the patella should lie below the anterior surface of the femoral shaft with knee flexed to 900.

Axial view can demonstrate a vertical fracture and osteochondral defects.

Axial view is obtained with patient’s supine on x-ray table and knee flexed to 450. The x-ray beam is angled to 300 from the horizontal and the cassette is placed perpendicular to the x-ray beam.

MEDIAL MALLEOLAR FRACTURE

Mechanism of injury:

Medial malleolus fracture most commonly occurs at the shoulder of medial plafond and extends obliquely in a proximal medial direction, this fracture includes both the anterior and posterior colliculus, which are avulsed during abduction or external rotation of talus in the mortice. More vertical fractures are caused supination adduction forces.

Radiographic findings:

In the acute trauma setting, the standard x-ray views of the ankle include mortise, anteroposterior (AP), and lateral nonweight-bearing views. Later, as the patient is able to stand comfortably, weight-bearing views are preferred to check alignment and stability.

Clinical features:

There will be pain and swelling of the ankle after the trauma with tenderness over the medial malleolus, inversion and eversion of ankle causes pain. The medial malleolus is reduced from a medial approach and reduced with a reduction forceps and fixed internally depending on the type of fracture pattern. Non-displaced fractures are treated with cast immobilization. Large fragments are fixed through a single lag screw. A small fragment is fixed with combination of 4 mm lag screw and Kirschner wire. Tension band wiring is used for low transverse fracture. A vertical counter sunk 4 mm lag screw is used for low transverse fracture.

CLASSIFICATION

OLECRANON

Depending on amount of articular surface involvement

Type 1: Fracture involves the proximal third of the articular surface.

Type2: Fracture involves the middle third.

Type3: Fracture involves the distal third.

Colton's Classification

This reflects displacement and the shape of fracture.

a. Non-displaced and stable (less than 2 mm of displacement and no change in position with gentle flexion to 900.

b. Displaced

- Avulsion
- Transverse fracture
- Comminuted fracture
- Fracture dislocation

Muller's Classification (AO/ASIF)

- Transverse fracture opposite to deepest part of trochlear notch
- Oblique fracture running distally from midpoint of trochlear notch
- Comminuted fracture
- Fracture olecranon associated with other injuries around the elbow

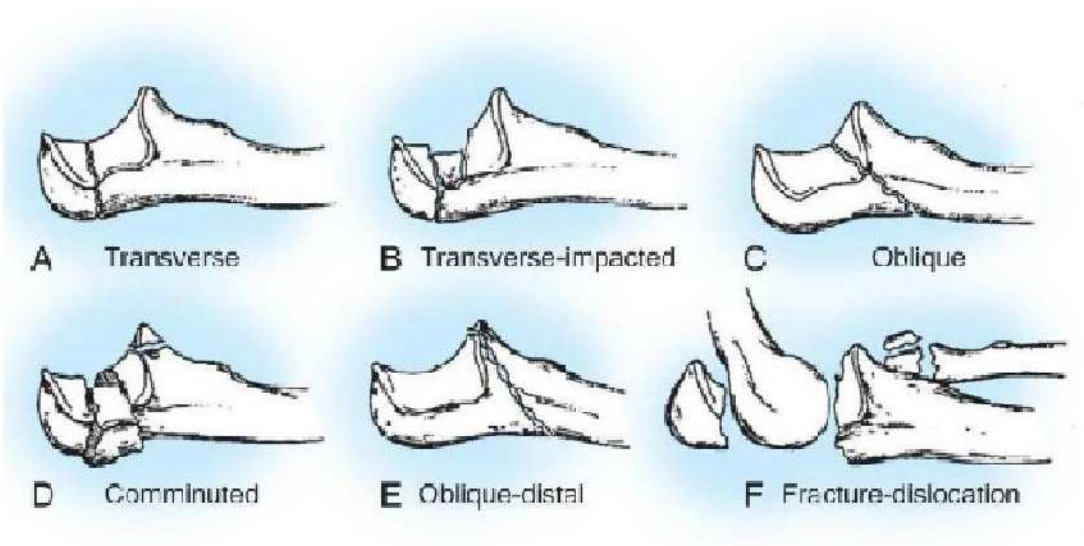


Fig 8. Schatzker classification of olecronon fractures

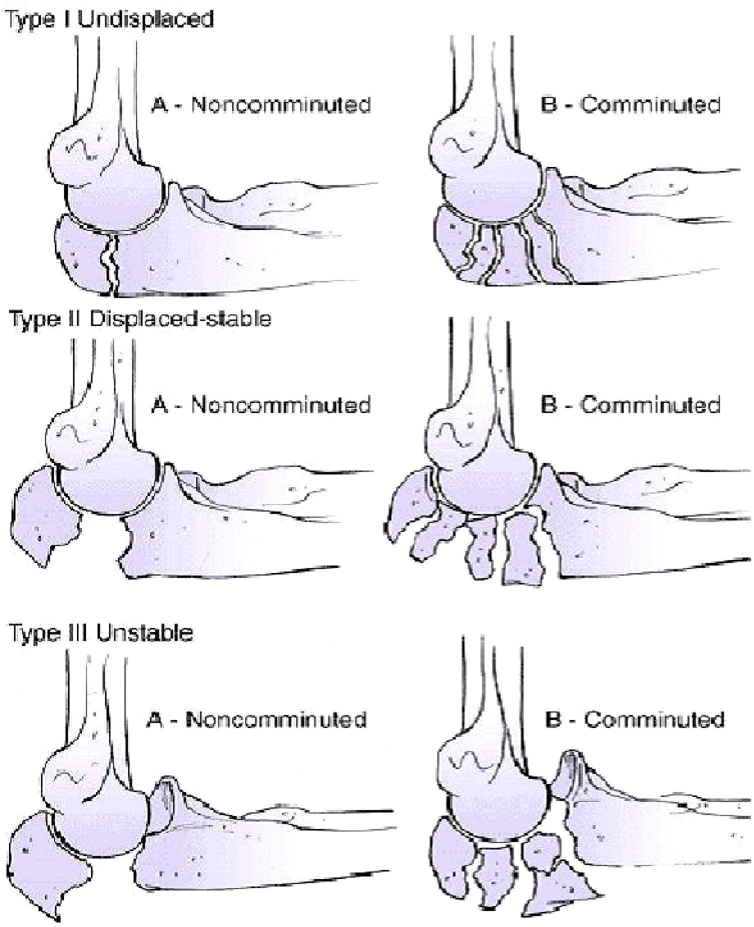


Fig 9. Mayo classification of Olecronon fractures

PATELLA

Orthopaedic trauma association classification

1. Non-displaced:

- Transverse
- Stellate
- Vertical

2. Displaced:

- Transverse
- Stellate
- Polar –Proximal and Distal

3. Osteochondral

AO Classification

A: Patella extra-articular

A1: Patella extra-articular avulsion

A2: Patella extra-articular, isolated body

B: Partial articular, extensor mechanism intact

B1: Partial articular vertical, lateral

1. Simple

2. Multifragmentary

B2: Partial articular, vertical, medial

1. Simple

2. Multifragmentary

B3: Partial articular, multifragmentary

C: Complete articular, disrupted extensor mechanism

C1: Complete articular, transverse

1. Middle

2. Proximal

3. Distal

C2: Complete articular, transverse plus two fragments

1. Middle

2. Proximal

3. Distal

C3: Complete articular, complex

1.3 fragments

2. >3 fragments

3. Non-Reconstructible

Displaced fractures: It is defined displaced, if fractures fragment separation is more than 3 mm or an articular incongruity of 2 mm or more.

Multifragmented fractures (Stellate fracture) result from direct compression with varying degrees of communition and displacement

Unusual fracture patterns:

Kroner first described osteochondral fractures, which are usually seen in patients 15 to 20 years of age. These fractures involve either the medial facet of patella or lateral femoral condyle after subluxation or dislocation of patella.

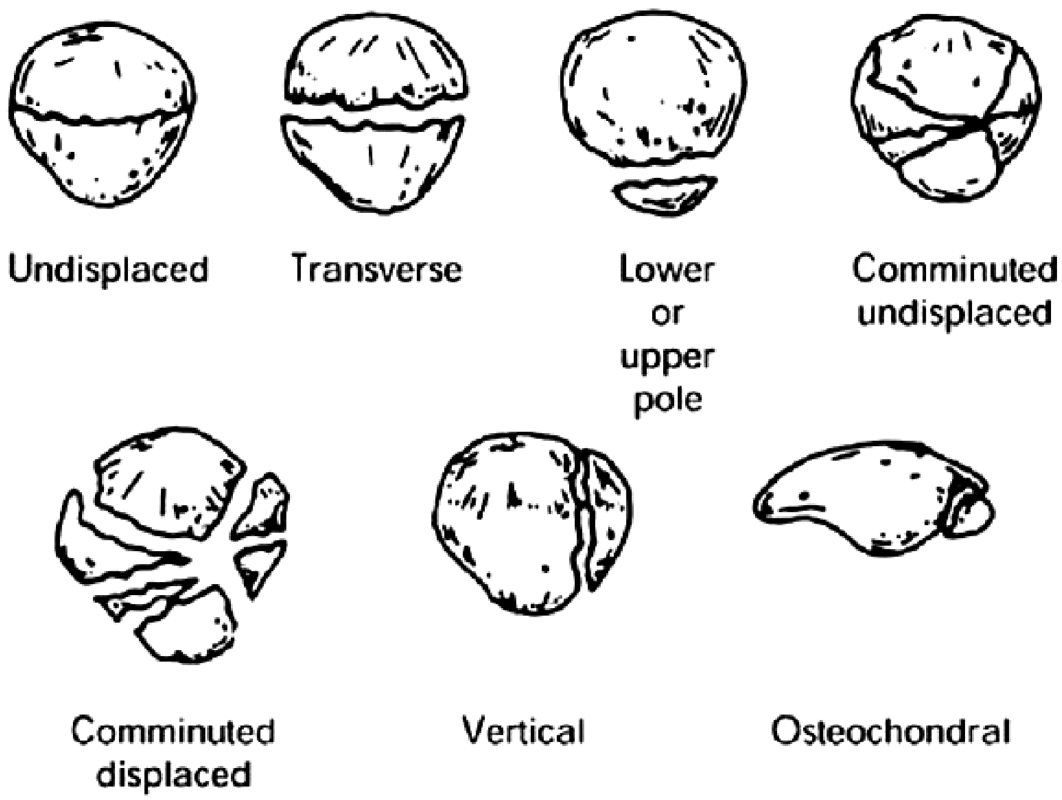


Fig 10. Classification of patellar fractures

ANKLE FRACTURES

Lauge-Hansen Classification

A. Supination-Adduction

1. Transverse avulsion type fracture of the fibula
2. Vertical fracture of the medial malleolus.

B. Supination-Eversion (External Rotation)

1. Disruption of the anterior tibiofibular ligament.
2. Spiral oblique fracture of the distal fibula.
3. Disruption of the posterior tibiofibular ligament or fracture of the posterior malleolus.
4. Fracture of the medial malleolus or rupture of the deltoid ligament.

C. Pronation-Abduction

1. Transverse fracture of the medial malleolus or rupture of the deltoid ligament.
2. Rupture of the syndesmotic ligaments or avulsion fracture of their insertions.
3. Short, horizontal, oblique fracture of the fibula above the level of the joint.

D. Pronation eversion (External rotation) (PER)

1. Transverse fracture of the medial malleolus or disruption of the deltoid ligament.
2. Disruption of the anterior tibiofibular ligament.
3. Short oblique fracture of the fibula above the level of the joint.
4. Rupture of posterior tibiofibular ligament or avulsion fracture of the posterolateral tibia.

E. Pronation dorsiflexion (PD)

1. Fracture of the medial malleolus.
2. Fracture of the anterior margin of tibia.
3. Supramalleolar fracture of the fibula.
4. Transverse fracture of the posterior tibial surface.

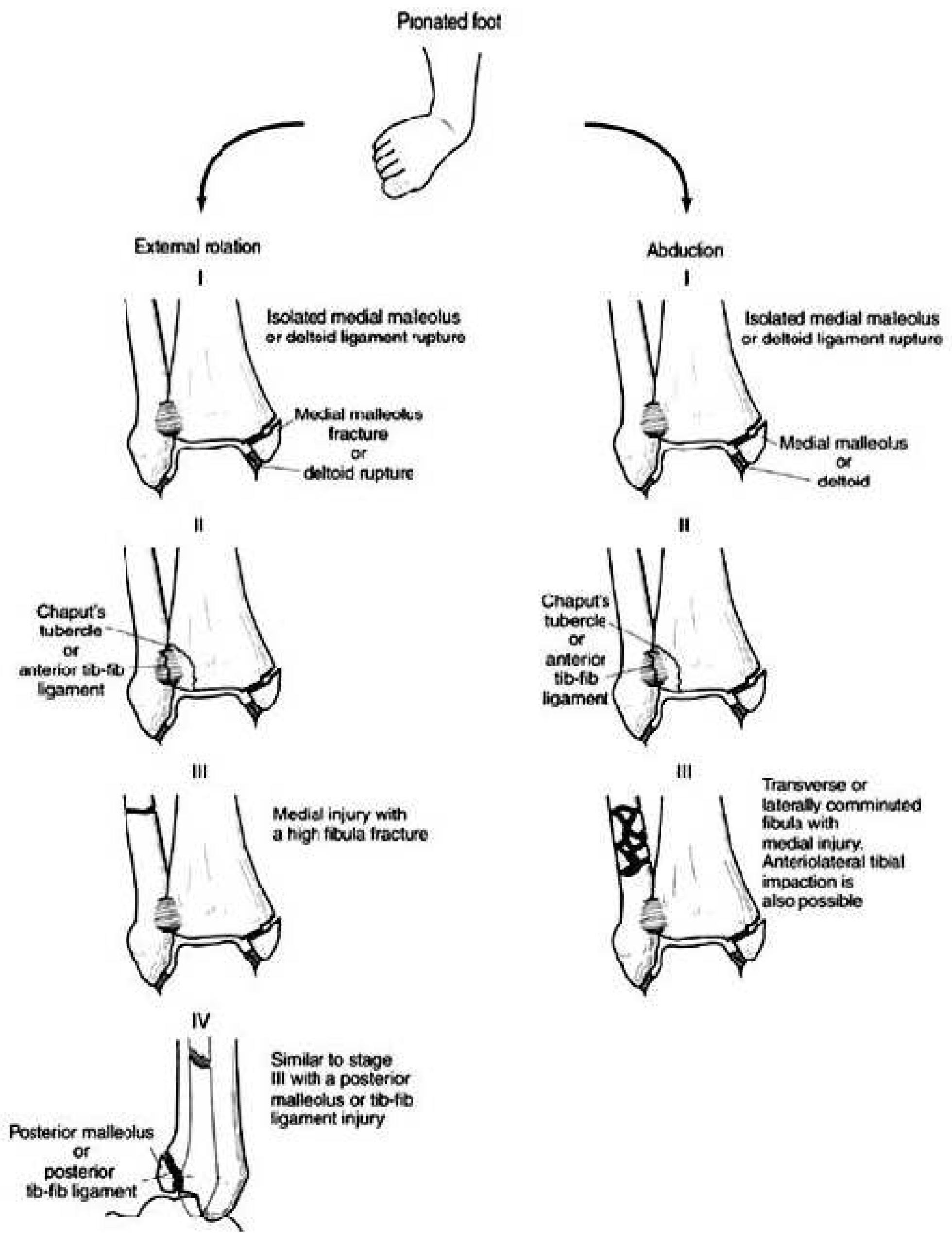


Fig 11. Lauge-Hansen Classification (Pronation Injuries of Ankle)

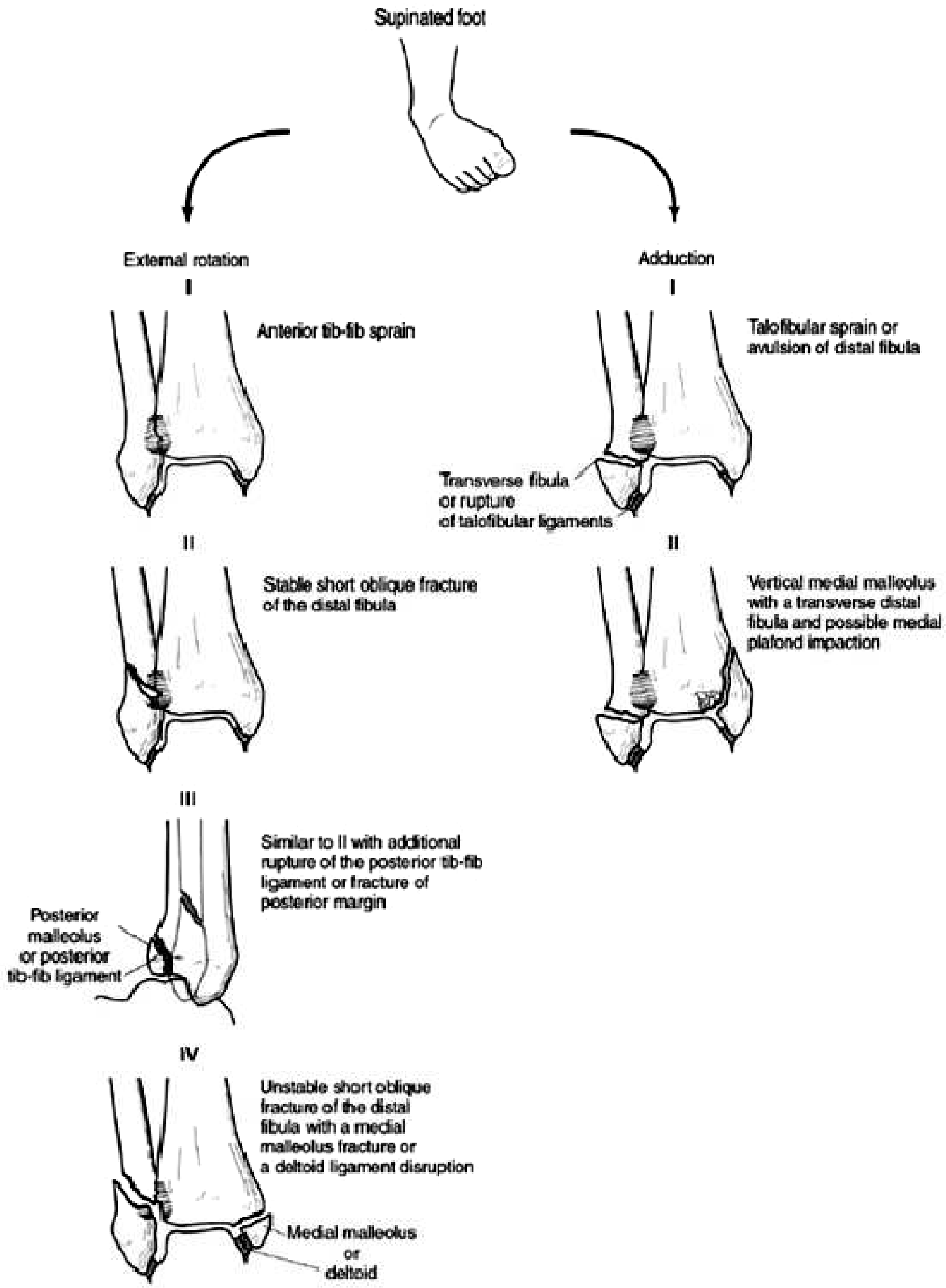


Fig 12. Lauge-Hansen Classification (Supination Injuries of Ankle)

Denis Weber Classification:

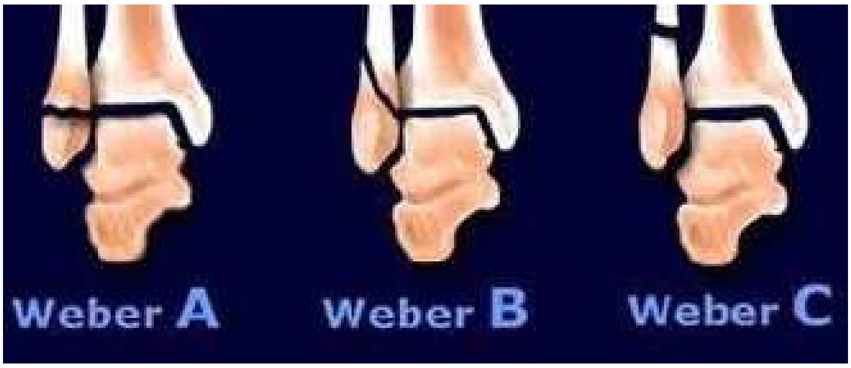


Fig 13. Dennis Weber classification

This is based on the position and appearance of fibular fracture.

Type A: Fracture of the fibula below the level of tibial plafond.

Type B: Oblique fracture of the lateral malleolus.

Type C:

C1: Oblique fracture of the fibula proximal to the disrupted tibiofibular ligament

C2: More proximal fibular fracture with extensive disruption of the interosseous membrane.

AO Classification

Type A: Fibular fracture below syndesmosis (Infra syndesmotic)

A1: Isolated

A2: With fracture of medial malleolus A3: With posterior medial fracture

Type B: Fibular fracture at the level of syndesmosis (Trans syndesmotic)

B1: Isolated

B2: With medial lesion

B3: Medial lesion with fracture of the posterolateral tibia.

Type C: Fibular fracture above syndesmosis (Supra syndesmotic)

C1: Diaphyseal fracture of the fibula, simple.

C2: Diaphyseal fracture of the fibula, complex.

C3: Proximal fracture of the fibula.

Handerson's radiological classification

a. Isolated fracture of lateral, medial, anterior or posterior malleolus.

b. Bimalleolar fractures.

c. Trimalleolar fractures

Ashhurst and Bromer classification

a. Fracture caused by external rotation

b. Abduction fracture

c. Adduction fracture

d. Axial rotation fracture

MANAGEMENT OF OLECRANON FRACTURES

Undisplaced fractures:

Displacement is not more than 2 mm and there is no change in position with gentle flexion to 90^o or with extension against gravity. Most authors agree that undisplaced fractures may be treated by immobilization in a long arm cast with elbow in 90^o of flexion for 3 to 4 weeks followed by protected range of exercises, avoiding flexion past 90^o until healing is complete radiographically.

The goals of treatment of displaced fractures are:

- Maintain power of elbow extension.
- Restore the congruity of articular surface. Restore the stability of the elbow.
- Prevent stiffness of joint.
- Early mobilization of joints.

Open reduction and fixation with tension band wiring

An incision is taken 2.5 cms proximal to the olecranon and parallel with its lateral border. It is carried distally 7.5 cms close to the lateral border of the shaft of the ulna. A hole is drilled from side-to-side in the digital fragment. Stainless steel wire is passed beneath the aponeurosis of the triceps muscle and around tip of olecranon. One end of the wire is carried obliquely across the posterior aspect of the fracture to the opposite side of the digital fragment and passed through the drill hole and then obliquely across the fracture again to opposite side of triceps. The wire loop is twisted tightly.[53]

After treatment:

A posterior plaster splint is applied with the elbow at 90^o. At 7-10 days active assisted movements are started. The splint is removed by 4 weeks.

1. Intramedullary fixation.

It is indicated if the fracture is comminuted and its distal fragments and the head of the radius are dislocated anteriorly. With a threaded pin or 6.5 mm AO screw, 10-12.5 cms long is drilled into the olecranon towards the medullary canal of the ulna until its point emerges at the fracture. Then the fracture is reduced and the screw is drilled to the distal fragment.

A combination of intramedullary pin or screw and tension bands:

Two parallel intramedullary 2mm Kirschners wires and then a figure of eight loop of number 20 stainless steel wire combining intramedullary and tension band principles. Stainless steel wire is passed through a transverse hole drilled in the distal fragment and then passed over the posterior surface of the olecranon around the protruding Kirschners wires and tightened with a twist.

2. Plate fixation

Hand contoured, semi-tubular plates and screws are used if comminution with bone loss prevents the use of tension band wire.

3. Excision of proximal fragments

It is advocated for old un-united fractures, comminuted fractures, fractures in the elderly and any fracture not involving the trochlear notch[54] and repair of triceps retinaculam.

Complications of olecranon fractures:

1. Decreased range of motion

Loss of motion can be minimized by firm internal fixation and early range of motion of the joint. Eriksson and colleagues reported that up to 50% of patients have limited range of motion of the elbow after olecranon fractures, generally withloss of extension. However, in their series, the limitations were not great, and only3% of the patients were aware of it.[58]

2. Post-traumatic arthritis

If reduction to less than 2-mm offset cannot be obtained, the possibility of arthritis developing later is significant. In the event of articular cartilage and bone loss, cancellous grafting in the defect may provide a fibrocartilaginous surface after graft revascularization.

3. Non-union

Nonunion of the olecranon has been reported to occur in 5% of olecranon fractures. The treatment of a nonunion should be suited to the patient. In a young, active patient the pseudoarthrosis may be taken down and the fracture site re-approximated and held with a tension-band wire or a suitable intramedullary device. Bone graft should be used to fill any defects in the fracture construct. Plate fixation may be needed, depending on the configuration of the fracture. Excision of the proximal portion of the pseudoarthrosis and repair of the triceps tendon is also an acceptable method of management, especially in older patients.[55]

MANAGEMENT OF PATELLA FRACTURES

It is based on the type of fracture. The goals of treatment are: 1. Preserve the patella function. 2. Restore continuity of extensor mechanism 3. Reduce complications associated with articular surface.

Treatment options include:

1. Non-operative treatment: It is indicated for

   a. Undisplaced fractures with an intact extensor mechanism.
   b. Fragment displacement less than 3 mm or articular displacement more than 2mm
   c. A cylinder cast is applied with knee in extension from groin to just above ankle.

2. Operative treatment: It is indicated for:

   a. Displaced fractures for more than 3 mm separation of fragments.
   b. Articular displacement more than 2 mm.
   c. Comminuted fractures.
   d. Osteochondral fracture with displacement of loose body in the joint.
   e. Open fractures

Procedure:

The classical approach is transverse incision over mid portion of patella, which gives access to retinaculum damage without developing flaps. Mid line incision used for this procedure will become important if reconstructive surgery is contemplated in future.[56]

Types of patellar fixation

1 Circumferential wire loop fixation

A wire loop is threaded though the soft tissues around the patella. Rigid fixation is not achieved and hence it is largely been replaced by more rigid fixation techniques to permit early motion of the joint.

2 Magnusson wiring

Two holes are made through the proximal fragments beginning at the medial or lateral borders of the quadriceps tendon and directed obliquely downwards to open on the fracture surface. Two holes in the distal fragment are drilled and their apertures are faced opposite to those of the proximal fragment. Stainless steel wire is threaded distally through the medial holes and then proximally through the lateral holes. After opposing the fragments the ends of the wire are drawn taut and twisted together.

3 Tension band wiring

Here two sets of wires are used, one passed transversely through the insertion of quadriceps tendon immediately adjacent to the superior pole then passing anteriorly over the superficial surface of patella and in a similar way through the insertion of patellar tendon. The wire is tightened until the fracture is slightly over corrected or opened on the articular surface. The second wire is passed through transverse holes drilled in the superior and inferior poles of the anterior patellar surface and tightened.

4 Modified tension band wiring

Two Kirschners wires are drilled from the inferior to superior poles through each fragment as parallel as possible. 18-gauge wire is passed transversely through the quadriceps tendon attachment deep beneath the 57 protruding Kirschner wires, then over the anterior surface of the reduced patella, then transversely through the patellar tendon attachment on the inferior fragment and deep beneath the protruding Kirschner wires, then back over the anterior patellar surface and then tightened at the upper end. Alternatively, the wire can be placed in the figure of eight fashion.

5 Lotke longitudinal anterior band wiring

A steel wire is passed through a hole drilled on the medial side of each fragment passing at the lower border and then through a hole drilled on the lateral side and tightened at the upper hole.

6 Partial patellectomy:

Indicated when there is severe comminution of one pole that is not amenable to internal fixation.

7 Total patellectomy:

Recommended for highly displaced, comminuted patella fracture, where reconstruction of patellar surface is not possible and those fractures that are not amenable to internal fixation.

Post-operative Management:

The limb is placed in extension in a posterior splint or knee brace. Isometric exercises are started on the first postoperative day. Active range of motion is performed when the wound had healed approximately after two to three weeks. The brace is discontinued at 6-8 weeks.[58]

Complications of patellar fractures:

1. Fracture fragment separation and dehiscence of the fracture repair are uncommon. They generally result from either inadequate internal fixation or, in some cases, an inadequate period of postoperative joint support. Nummi reported a 7.4% incidence of late displacement after treatment of patellar fractures by closed methods. He noted an 11% incidence of loss of fragment position after osteosynthesis.[58]
2. Refractures are rare in nearly all series; the incidence varies from less than 1% to 5%. The trauma responsible for refracture is usually minimal. Treatment must be individualized to the patient. Repeat osteosynthesis may be necessary for moderate displacement and extensor mechanism insufficiency.
3. Avascular necrosis is reported by most authors to be rare; however, Scapinelli reviewed 162 transverse fractures of which 41 showed partial evidence of necrosis; 38 of these involved the proximal fragment. Treatment consists of observation only. Patients usually regain full knee

function within 6 to 8 months, and varying degrees of patellofemoral arthritis usually develop. Revascularization usually occurs spontaneously within 2 years.

4. Patellofemoral pain or osteoarthritic symptoms may develop as late sequelae of patellar fracture. Nummi reported a long-term incidence of patellofemoral arthritis of 56.4% in more than 700 fractures. Conservative management of patellofemoral joint pain using non-steroidal anti-inflammatory agents and physical therapy is the mainstay of treatment. Under certain circumstances, the anterior tibial tubercle advancement advocated by Maquet may provide resolution of symptoms andimproved extensor mechanism function; this isusually indicated in young patients with intractable knee pain.[58.59]
5. Postoperative wound infection is managed by debridement and evaluation of the stability of the fixation. Wound infection with stable fixation and viable bone fragments is treated by debridement, irrigation, and closure over drains with intravenous antibiotics.
6. Persistent infection in the presence of devitalized bone fragments requires excision of nonviable bone and plastic repair of the extensor mechanism. Any exposure of the knee articular cartilage to chronic infection results in progressive deterioration of both knee function and joint space. After repair of the residual extensor mechanism, the knee is immobilized until healing occurs. Partial to total patellectomy may be required to gain

control over the infection process. Loss of knee function and degenerative changes are common sequelae.

7. Non-union: There is a low incidence (2.4%) of patellar fracture nonunion. Non-union may be well tolerated by patients with limited or decreased functional demands on the knee. Nummi reported 14 of 17 non-unions as having satisfactory results. Repeat osteosynthesis may be indicated to obtain union in more active, young individuals. Partial patellectomy may be considered in the painful nonunion associated with avascular necrosis.[58]

8. Painful retained hardware is common and is usually related to tendon or capsular irritation from Kirschner-wire penetration or the twisted ends of cerclage wires. Removal of the hardware usually alleviates these symptoms. Fractures of the cerclage wire are managed by removal if symptomatic. Cancellous 4.0- or 3.5-mm lag screws are difficult to remove if left for several years within hard young bone.[60]

MANAGEMENT OF MEDIAL MALLEOLAR FRACTURE

The medial malleolus is reduced from a medial approach and reduced with areduction forceps and fixed internally depending on the type of fracture pattern. Undisplaced fractures are treated with cast immobilization.

Large fragments are fixed through a single lag screw. A small fragment is fixed with combination of 4 mm lag screw and Kirschner wire.

Tension band wiring is used for low transverse fracture. A vertical counter sunk 4 mm lag screw is used for low transverse fracture.

After treatment

The ankle is immobilized in a posterior splint in neutral position. Active movements are started from the first postoperative day. Weight bearing is restricted for 6 weeks.

Complications of medial malleolar fractures:

1. Non-union

Most non-unions involve the medial malleolus. These are often avulsion injuries that were initially treated closed and fail to unite because of residual displacement of the fracture, interposed soft tissue, or associated lateral instability resulting in shearing forces on the fracture from the pull of the deltoid ligament. A nonunion in the distal portion of the medial malleolus is often not symptomatic especially if the lateral ankle is stable. Non-unions at the level of the joint may cause chronic pain, swelling, and a feeling of instability. Symptomatic non-unions have been treated with open reduction and internal fixation and sometimes with electrical stimulation. An exact reduction may be difficult because of resorption at the fracture site and 61 remodeling of the fracture edges. Osteoporosis of the distal fragment may make fixation difficult. Gaps are filled with bone graft, and fixation is performed with either a tension band technique or cancellous screws.

2. Wound Problems

Marginal necrosis of skin edges after surgery occurs in about 3% of patients. Carragee and associates reviewed the early complications in 121 surgically treated closed ankle fractures and found that fractures with skin blisters or abrasions had more than double the overall complication rate. These problems can be decreased by avoiding surgery during the period of increased swelling; minimizing tourniquet time; careful handling of the soft tissues, especially the skin edges; gentle retraction; use of implants appropriate for the size of the fracture fragments; wound closure without tension; appropriate drainage of the wound; and avoiding constrictive postoperative dressings.

3. Infections

The infection rate in treating closed fractures with the current techniques of internal fixation is less than 2%superficial infections may resolve with local wound care and antibiotics. If needed, the incision can be reopened and the wound treated with dressing changes or whirlpool or both. Deep infections require formal exploration and debridement of the joint. The fixation should be left in place if it is stable and the fracture is not healed. Preservation of the joint depends on the organism involved, amount of articular damage present, and response to treatment. Infections with bone involvement and most gram negative infections require extensive debridement, and an arthrodesis may be required as a salvage procedure.[62]

4. Arthritis

Degenerative arthritis can result from damage to the articular cartilage at the time of the injury, from altered mechanics of the joint resulting from ligamentous instability or inadequate reduction of the fracture, or from both. Anatomical reduction does not totally prevent the development of degenerative changes because blunt injury to the articular surfaces is not correctable. Degenerative changes were reported in about 10% of fractures that were adequately reduced and in 85% of those inadequately reduced; these radiographic changes were usually present within 18 months of injury. The incidence of arthritis increases with the severity of the injury. An increased incidence was also found in older patients, especially in women with osteoporosis. Considering the frequency of ligament andbony injuries involving the ankle, the incidence of degenerative arthritis of the ankle is surprisingly low. The clinical findings do not always correlate with the radiographic appearance of the joint. For symptomatic arthritis unresponsive to nonoperative modalities, an ankle arthrodesis is the most predictable reconstruction.

Materials & Methods

MATERIALS AND METHODS

Study design: Longitudinal cohort study

Study setting: Orthopaedics Department Sree Mookambika Institute of Medical Science, Kulasekharam during the decided study period.

Approximate duration of study: **18 months (April 2016 to May 2017)**

Groups to be studied: Single Group of 60 samples was studied

Detailed description of the groups:

Patients who are diagnosed as fractures of Olecranon or Patella or Medial malleolus in the dept. of orthopaedics at Sree Mookambika institute of Medical Sciences, who fulfil the criteria of inclusions are included in the study.

Scientific basis of sample size used in the study:

Sample size calculated using the formula $=\frac{2(Z_\alpha+Z_\beta)^2 \mathrm{P}(1-P)}{(P_1-P_{2)}{}^2}$

$== \frac{15.68 \text{ x } 60.5 \text{ x } 39.5}{3025} = 12.58$

Sample size

$=\frac{2(Z_\alpha+Z_\beta)^2 \mathrm{P}(1-P)}{(P_1-P_{2)}{}^2}$

Z_α= 1.96 at class interval

Z_β= 0.84 at 80% power

P_2= 33% excellent results of tension band wiring(8)

P_1= 88% excellent results of tension band wiring(9)

P= $\frac{\mathrm{P_1+P_2}}{2}$ 60 Samples were taken

Sampling technique used: Convenient Sampling Technique

Inclusion criteria:

- All closed displaced transverse fracture of Patella or Olecranon or Medial Malleolus.
- Age more than 18 years.
- Sex both male and female.

Exclusion criteria:

- Comminuted fractures.
- Any established deformity of knee, ankle & elbow prior to the fracture.
- Fracture associated with other ligamentous and bony injuries.
- Compound fractures.

Clinical trial registration was made with Clinical Trial Registry of India (CTRI) and the reference no was REF/2015/04/008769

OPERATIVE TECHNIQUES

Anaesthesia

- Spinal anaesthesia was given for surgery of patellar and malleolar fracture.
- Regional block or general anaesthesia for surgery of olecranon fracture was given considering patient's condition.

Patient positioning

- Patient was positioned supine in patella fractures.
- Lateral side in malleolar and olecranon fractures.

Tourniquet

- Pneumatic tourniquet was applied to arm after exsanguination for olecranon fracture and to thigh in patellar and malleolar fracture.

Painting and draping

Affected part was scrubbed, painted and draped

TECHNIQUE OF OPEN REDUCTION

PATELLA

A midline longitudinal incision approximately 12.5 cms long was taken. The skin and subcutaneous tissue were reflected medially and laterally to expose the anterior surface of patella. Fracture surfaces were cleaned of blood clot and small fragments. Thorough lavage was given. Fracture fragments were reduced anatomically with towel clips or bone holding forceps restoring smooth articular surface. 2 mm Kirschner wires were drilled from inferior to superior parallel to each other. These wires were placed 5 mm deep to anterior surface and protruding beyond the patella and quadriceps tendon attachments to the inferior and superior fragments. An 18-guage stainless steel wire was passed transversely through the quadriceps tendon attachment deep to the protruding Kirschner wires. Then over the anterior surface of patella, then transversely through patellar tendon attachment on the inferior fragment and deep to the protruding Kirschner wires, then back over the anterior surface and tightened at upper end. The reduction was checked by palpating the under surface of patella. The upper ends of the two Kirschner wires were bent anteriorly and cut short and rotated embedding posteriorly.

After treatment

The limb was placed in extension in a posterior splint. Isometric exercises were started on first postoperative day. Check dressing was done on 2nd postoperative day to know condition of operative wound. Following dressing, check x-ray in AP and lateral views were done. Active exercises were started after 2 weeks when wound was healed. Suture removal was done on twelfth postoperative day. Weightbearing was started after 6 weeks.

OLECRANON

An incision 2.5 cms proximal to the olecranon and parallel with its lateral border was taken and carried distally for 7.5 cm. The fracture was exposed and fragments freshened. The fracture was reduced with a towel clip and a drill hole was made from side-to-side in the distal fragment.

Two parallel Kirschner wires were passed perpendicular to fracture from proximal fragment into the medullary cavity. A 18-guage stainless steel wire was passed through hole in distal fragment and then crossed in figure of eight over the posterior surface of olecranon and passed beneath the protruding Kirschner wire and aponeurosis of triceps muscle. The wire was tightened to achieve reduction and Kirschner wire bent and buried.

After treatment

The limb was immobilized in posterior splint at 900 of flexion. Check dressing as done on 2nd postoperative day to know condition of operative wound. Following dressing, check x-ray in AP and lateral views were done.

Sutures were removed on twelfth postoperative day and gentle active assisted exercises were started. The splint was continued for four weeks

MEDIAL MALLEOLUS

An anteromedial incision was taken 2 cms proximal to fracture line and extended distally approximately 2 cm distal to tip of medial malleolus. The fracture site was exposed and freshened. Any interposed fold of periosteum was removed and loose fragments debrided. With a towel clip, the fracture was reduced. A transverse hole was drilled in proximal tibial about 2 cms from the fracture. Two parallel Kirschner wires were passed perpendicular to fracture site from distal fragment into the proximal fragment. A 18-guage stainless steel wire was passed through the transverse hole and then over the medial surface and then beneath the protruding Kirschner wires. The wire was tightened to achieve reduction. The Kirschner wires were bent, cut and buried.

After treatment:

Below knee POP slab was applied in neutral position. Check dressing was done on 2nd postoperative day to know condition of operative wound. Following dressing, check x-ray in AP and lateral views were done. Sutures were removed on twelfth postoperative day and active range of movements started. Weight bearing was allowed after 6 weeks.

Discharge:

Patient was discharged on 12th postoperative day

Follow up:

Follow up was done on OPD basis at 4th, 8th and 12th week postoperatively with clinical and radiological evaluation and the results were assessed based on:

- Pain Swelling Tenderness at fracture site Movements of related joint
- Radiological union

COMPLICATIONS:

1. Stiffness
2. K-wire migration
3. Skin necrosis
4. Infection

SCORING SYSTEMS USED

Table 2: Gaur's criteria for knee function evaluation[69]

Parameters	**Result**			
	Excellent	Good	Fair	Poor
Quadriceps Wasting	Nil	<1.5cm	Upto 2.5cm	>2.5cm
Quadriceps Power loss	Nil	<10%	Upto 25%	25%
Extension lag	No	No	$<10^{o}$	$>10^{o}$
Knee range of motion	Full	$0\text{-}110^{o}$	Upto 90^{o}	$<90^{o}$
Knee pain	No	Minimum	Moderate	Severe
Function	Normal	Normal	Restricted	Incapacitated

Table 3: American Orthopaedic Foot And Ankle Society - Ankle – Hindfoot Scale[70]

Sl. No	PAIN(40 POINTS)	
1	None	**40**
2	Mild , occasional	**30**
3	Moderate , daily	**20**
4	Severe , almost always present	**0**
	FUNCTION(50 POINTS)	
1	Activity limitations, support requirement - No limitations, no support - no limitations of daily activities, limitations of recreations activities, no support - limited daily and recreational activities, cane - severe limitations of daily and recreational activities, walker, crutches, wheelchair , brace	 **10** **7** **4** **0**
2	Maximum walking distance , blocks - greater than 6 - 4-6 - 1-3 - Less than 1	 **5** **4** **2** **0**
3	Walking surfaces - No difficulty on any surface - Some difficulty on uneven terrain , stairs , inclines, ladders - Severe difficulty on uneven terrain , stairs , inclines, ladders	 **5** **3** **0**
4	Gait abnormality - None, slight - Obvious - Marked	 **8** **4** **0**

5	Sagittal motion (flexion and extension) - normal or mild restriction (30 or more) - moderate restriction (15-29) - severe restriction (less than 15)	 **8** **4** **0**
6	Hindfoot motion (inversion plus eversion) - normal or mild restriction (75- 100%) - moderate restriction (25- 74%) - severe restriction (less than 25%)	 **6** **3** **0**
7	Ankle – hindfoot stability - Stable - Definitely unstable	 **8** **0**
	ALIGNMENT (10 POINTS)	
1	Good, plantigrade foot , midfoot well aligned	**15**
2	Fair, plantigrade foot , some degree of midfoot malalignement observed , no symptoms	**8**
3	Poor, nonplantigrade foot, severe mal-alignment , symptoms	**0**

Interpretation:

EXCELLENT - 90 TO 100

GOOD - 80 TO 89

FAIR - 70 TO 79

POOR - <70

Table 4: MAYO ELBOW PERFORMANCE SCORE[71]

SL.NO		POINTS
1.	PAIN - Non - Mild - Moderate - Severe	**45** **30** **15** **0**
2	MOTION - arc of motion greater than 100 degree - arc of motion between 50 – 100 degree - arc of motion less than 50 degree	**20** **15** **5**
3	STABILITY - stable - moderate instability - grossly unstable	**10** **5** **0**
4	FUNCTION - can comb hair - can eat - can perform hygiene - can don shirt - can don shoe	**5** **5** **5** **5** **5**

Interpretation:

EXCELLENT - > 90

GOOD - 75- 89

FAIR - 60 -7

POOR - <60

STATISTICAL METHOD USED

i. Statistical tests used:

- Descriptive statistics and Diagrammatic representation.

ii. Softwares used for data analysis

- Data was entered in Microsoft Excel 2010 spread sheet

Results

RESULTS

A longitudinal cohort study was conducted on 60 patients who are diagnosed as fractures of Olecranon or Patella or Medial malleolus in the department of orthopaedics at Sree Mookambika institute of Medical Sciences Among the total of 60 patients enrolled in this study, there were no deponents or loss to follow-ups.

The outcomes of the patients were evaluated clinically and radiologically on periodic basis. The Clinical evaluation was done using Gaur's criteria for knee function evaluation, American Orthopaedic Foot and Ankle Society - ankle – Hindfoot Scale and Mayo Elbow Performance Score

Table 5: Distribution of patients based on the age

Age (Years)	Number	Percentage (%)
20-30 Y	16	26.67
31-40 Y	24	40.00
41-50 Y	12	20.00
51-60 Y	8	13.33
Total	60	100.00

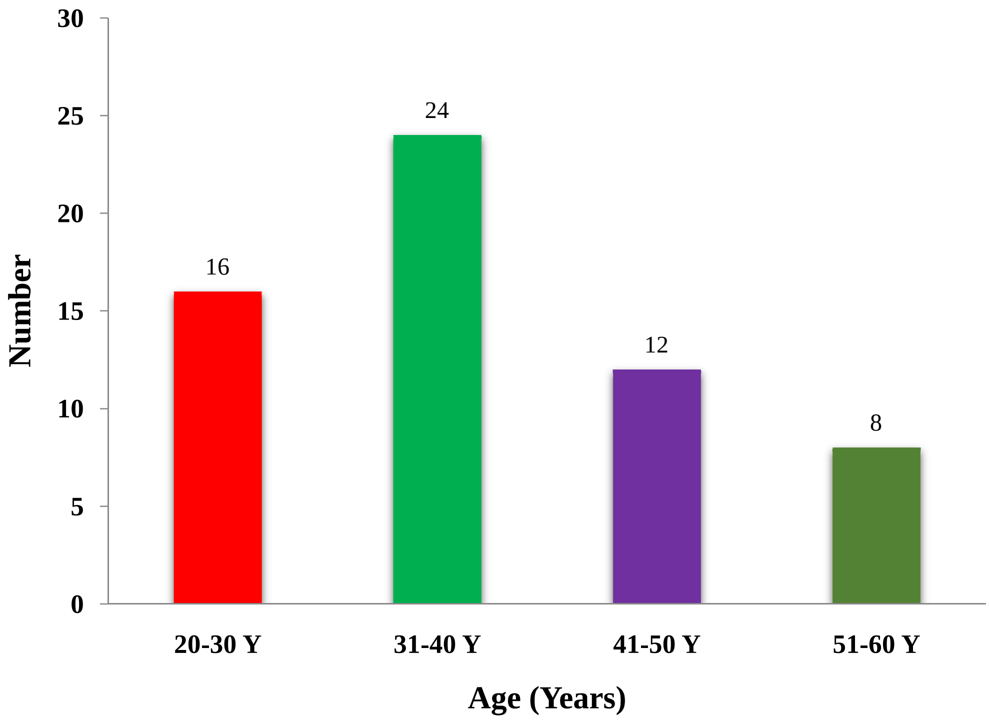


Fig 14. Distribution of patients based on the age

Out of 60 patients 40% patients aged between 31-40 years. 16 patients had age between 20-30 years and 12 patients had age between 41-50 years. Least number of patients was seen in age between 51- 60 years.

Table 6: Distribution of patients based on gender

Gender	Number	Percentage (%)
Male	45	75
Female	15	25
Total	60	100.00

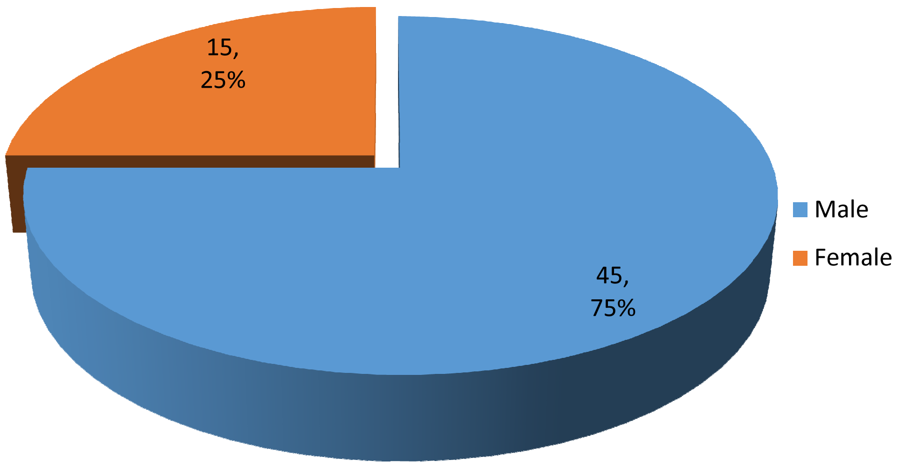


Fig 15. Distribution of patients based on gender

Males was more compared to females, were 75% was males in this study.

Table 7: Distribution of patients based on fracture side

Fracture side	Number	Percentage (%)
Right	36	60.00
Left	24	40.00
Total	60	100.00

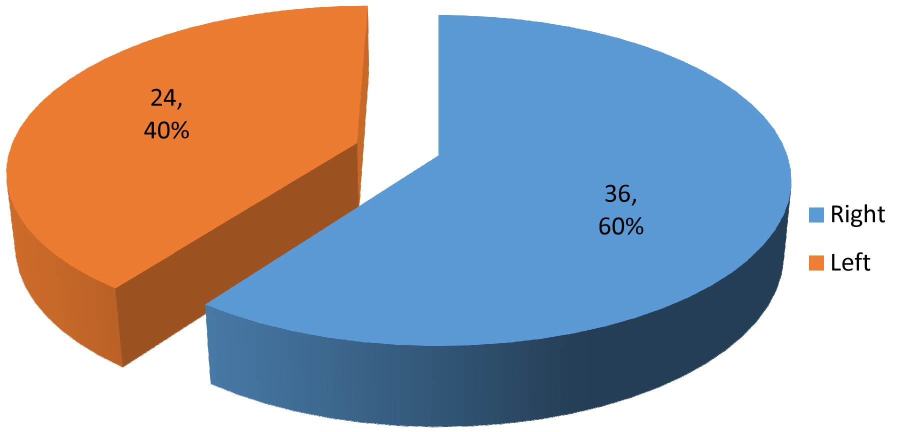


Fig 16. Distribution of patients based on fracture side

About 60.00% patients had fracture in right side. Only 40.00% had left side.

Table 8: Distribution of patients based on bone fracture

Bone	Number	Percentage (%)
Patella	20	33.33
Olecranon	20	33.33
Medial Malleolus	20	33.33
Total	60	100.00

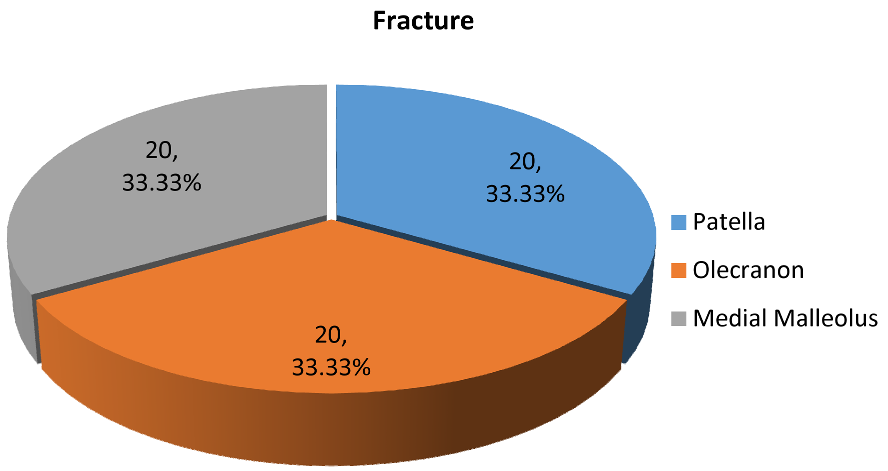


Fig 17. Distribution of patients based on bone fracture

Among the 60 patients 20 had patella fracture, 20 had Medial malleolus fracture and 20 patients had Olecranon fracture.

Table 9: Distribution of patients based on mechanism of injury

Mechanism of injury	Number	Percentage (%)
Direct	28	46.67
Indirect	32	53.33
Total	**60**	**100.00**

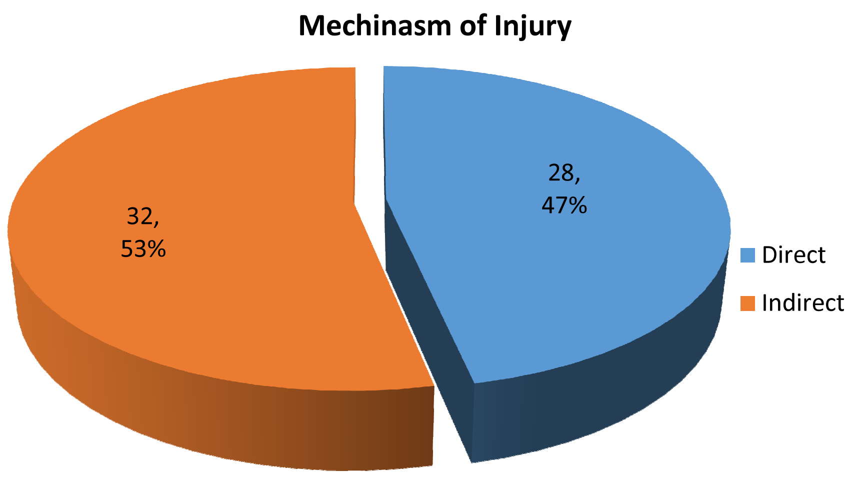


Fig 18. Distribution of patients based on mechanism of injury

32 patients had indirect mode of injury and others (47%) had direct mode of injury.

Table 10: Distribution of patients based on mode of injury

Mode of injury	Number	Percentage (%)
Assault by	12	20.00
Road traffic accident by	24	40.00
Domestic in Nature	22	36.67
Sports by	2	3.33
Total	60	100.00

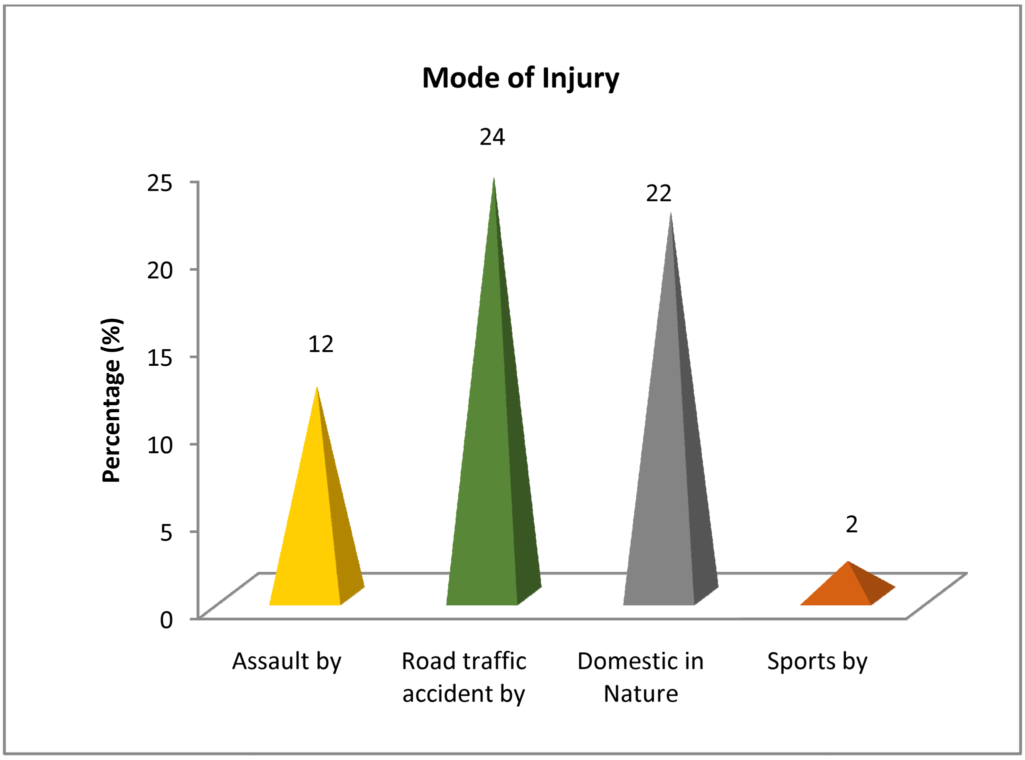


Fig 19. Distribution of patients based on mode of injury

Maximum patients had RTA (n=24) mode of injury. DN type had 22 patients. 12 patients had ASL type. Least number of patients had SPR (n=2) mode of injury.

Table 11: Distribution of patients based on associated injury

Associated injury	Number	Percentage (%)
Yes	4	6.67
No	56	93.33
Total	60	100.00

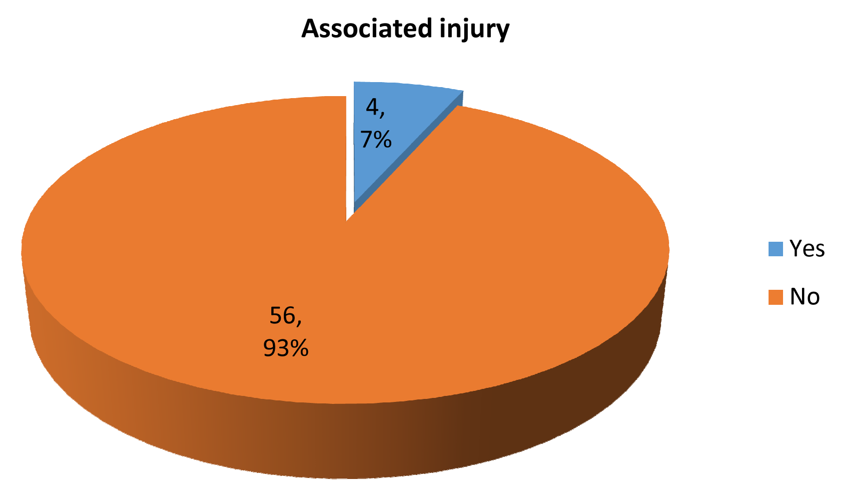


Fig 20. Distribution of patients based on associated injury

93.33% patients do not have any associated injury. Only 4 patients had associated injury.

Table 12: Distribution of patients based on radiological union in weeks

Radiological union in weeks	Number	Percentage (%)
8 weeks	8	13.33
9 weeks	3	5.00
10 weeks	7	11.67
11 weeks	19	31.67
12 weeks	12	20.00
15 weeks	6	10.00
18 weeks	5	8.33
Total	60	100.00

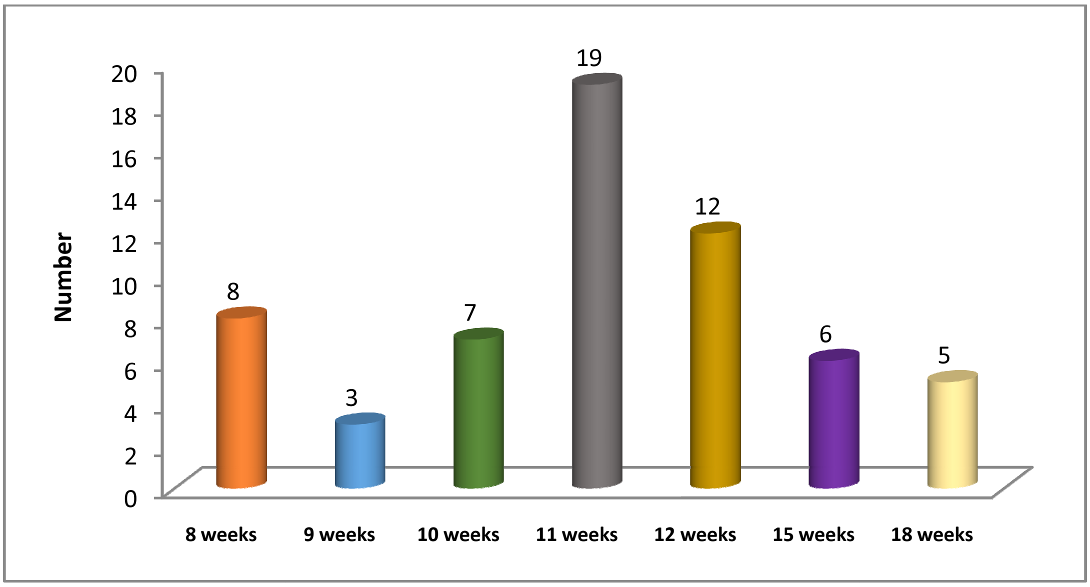


Fig 21. Distribution of patients based on radiological union in weeks

12 patients showed reunion within 12 weeks. 19 patients showed in 11 weeks. Least number of patients showed reunion at 9 (n=3), 18 (n=5) and 15(n=6) weeks. 8 patients had reunion in 8 weeks and 7 patients had reunion in 10 weeks. Maximum reunion was observed at 11 weeks.

Table 13: Distribution of patients based on pain

Pain	Number	Percentage (%)
Present	20	33.33
Absent	40	66.67
Total	60	100.00

66.67% patients do not have pain but 20 patients had pain.

Table 14 Distribution of patients based on type of complications

Complication type	Number	Percentage (%)
Nil	44	73.33
Stiffness	8	13.30
K-wire migration	4	6.67
Skin necrosis	2	3.33
Infection	2	3.33
Total	60	100.00

Maximum number of patients had no complications. 8 patients showed stiffness, 4 showed k-wire migration, 2 showed skin necrosis and another 2 patient showed infection.

Table 15: Distribution of patients based on final outcome

Final outcome	Number	Percentage (%)
Poor	13	13.33
Fair	10	6.67
Good	18	36.67
Excellent	19	43.33
Total	30	100.00

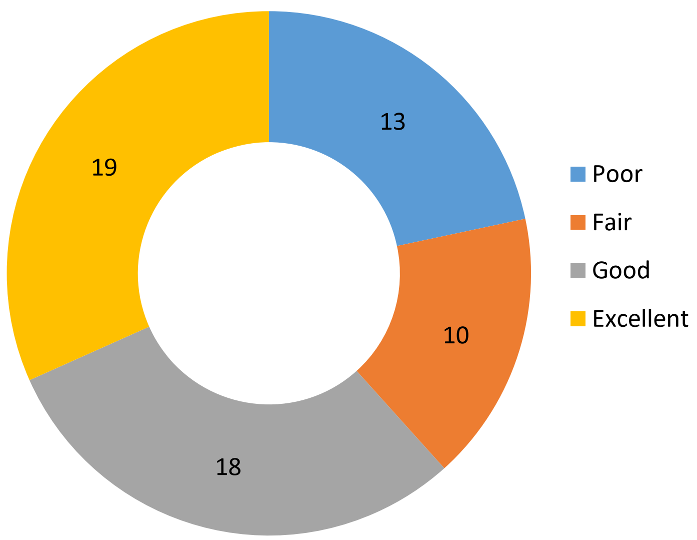


Fig 22. Distribution of patients based on final outcome

19 patients showed excellent outcome followed by 18 showed good. 10 patients showed fair and 13 showed poor outcome.

Table 16: Distribution of bone fracture with radiological reunion in weeks

Radiological reunion in weeks	Patella	OL	MM
8 weeks	6	1	1
9 weeks	3	0	0
10 weeks	3	2	2
11 weeks	7	6	6
12 weeks	1	5	6
15 weeks	0	4	2
18 weeks	0	2	3
Total	20	20	20

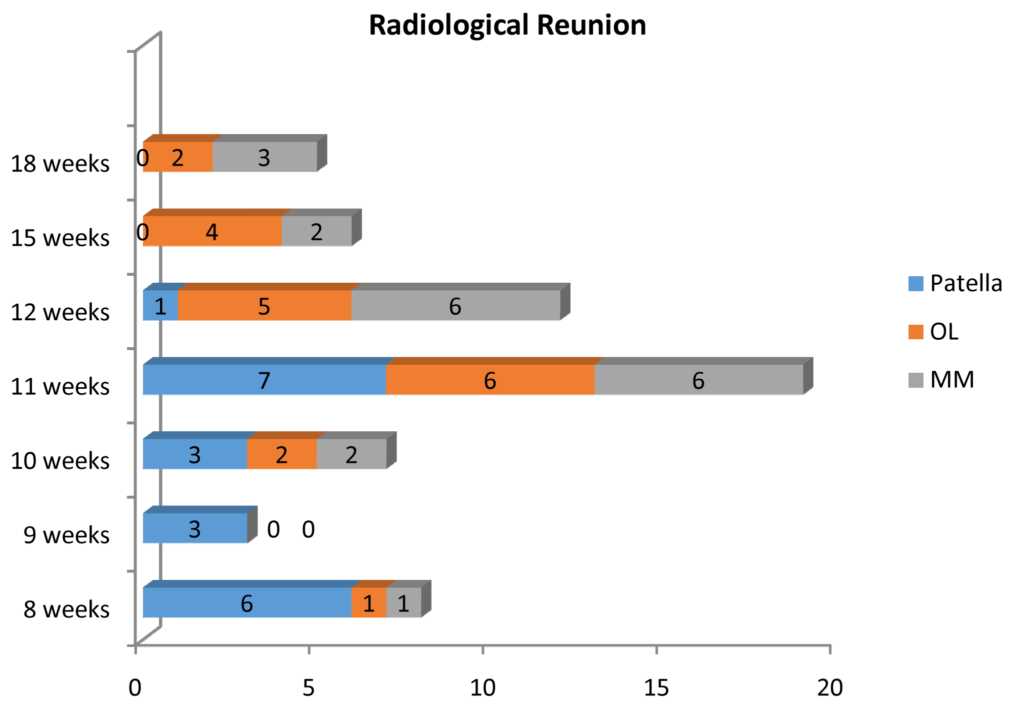


Fig 23. Distribution of bone fracture with final out come

6 patients in patella fracture showed reunion in 8 weeks and 7 at 11 weeks. 2 OL fracture patients showed reunion at 18 weeks. 3 in MM fracture showed reunion at 18 weeks and 2 at 17 weeks.

Table 17: Distribution of bone fracture with final out come

Final out come	Patella	OL	MM
Poor	1	5	7
Fair	2	4	4
Good	8	5	5
Excellent	9	6	4
Total	20	20	20

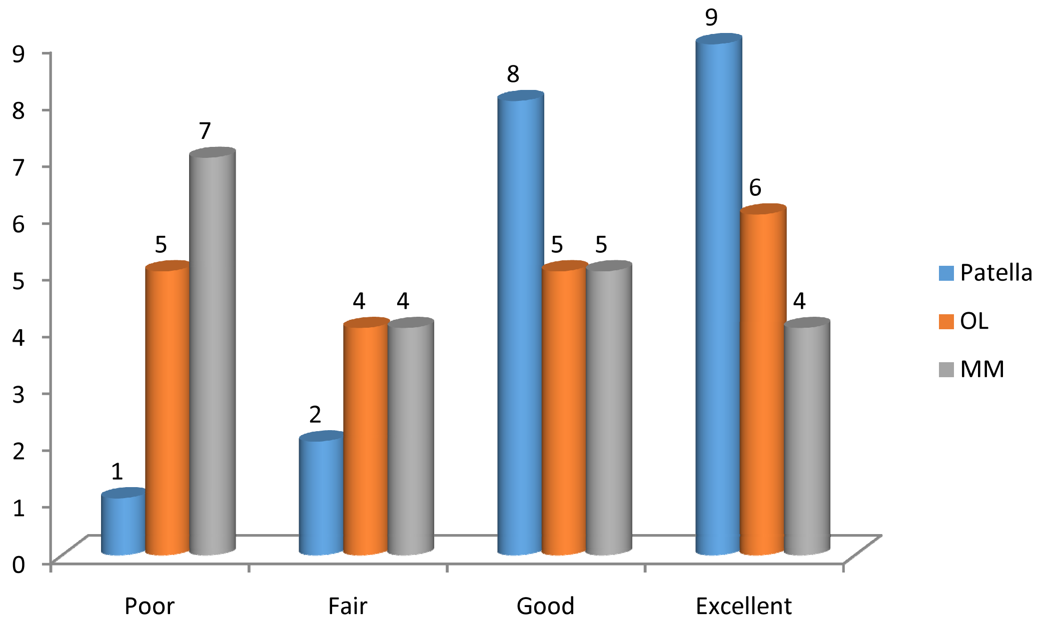


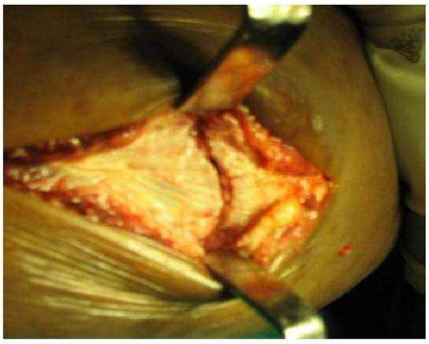
Fig 24. Distribution of bone fracture with final out come

9 Patella fracture showed excellent outcome. 5 OL fracture showed good outcome. 7 patients with MM fracture showed poor out come.

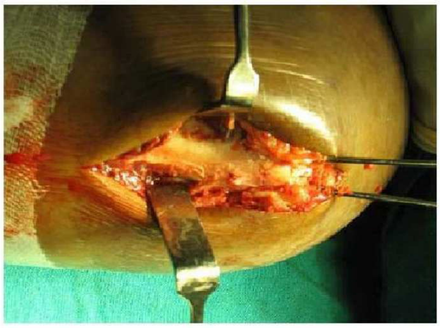
Clinical Examples

CLINICAL EXAMPLES

CASE 1: OLECRANON

Midline incision Exposure of the fracture site

Reduction with clamp Introduction of K-wires

Application of Tension Band Wiring

CASE 1: OLECRANON

PRE OPERATIVE

AFTER 4 WEEKS

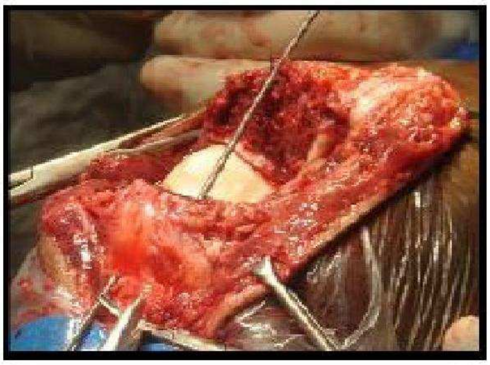
POST OPERATIVE 8 WKS

CASE 1: OLECRANON

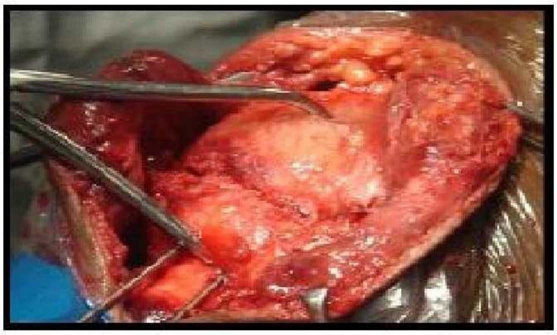
FUNCTIONAL RANGE OF MOTION

CASE 2 - PATELLA

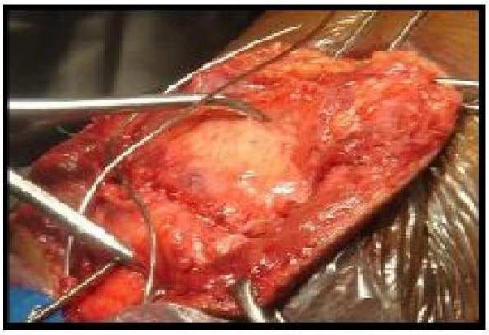
INCISION



K-WIRES INTO PROXIMAL



K-WIRES INTO DISTAL FRAGMENT



STEEL WIRE APPLICATION

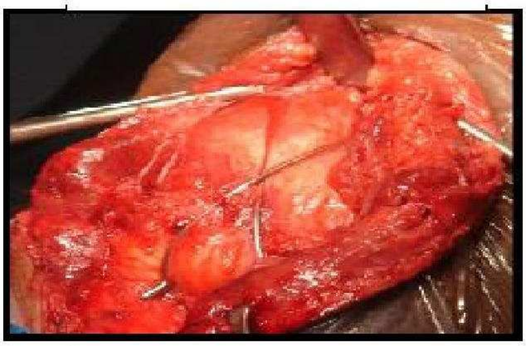


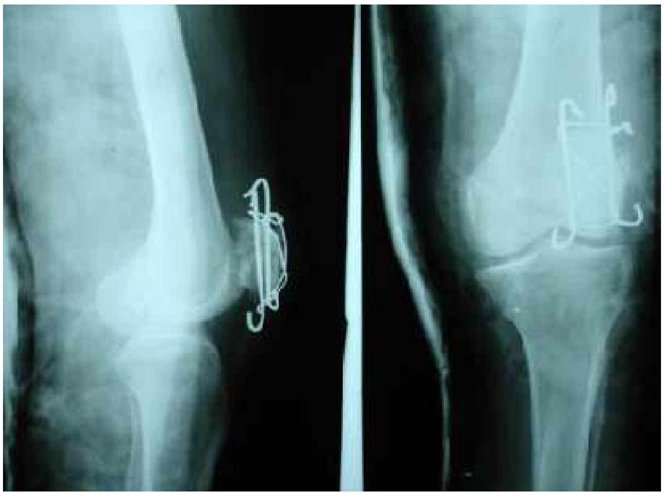
FIGURE 8 APPLIED

CLOSURE

CASE 2 - PATELLA

PRE OPERATIVE

POST OPERATIVE 4WKS



POST OPERATIVE 8 WKS

CASE 2 - PATELLA

FUNCTIONAL RANGE OF MOVEMENTS

CASE 3 - MEDIAL MALLEOLAR FRACTURE


Preparation

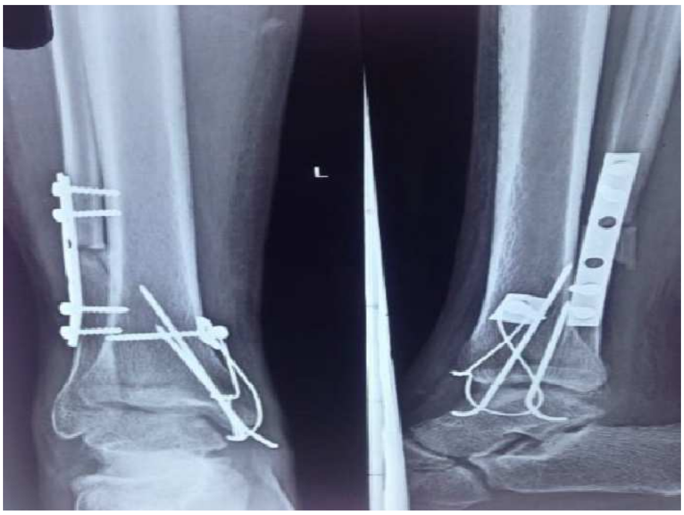

Exposure of the fracture site


Fixation of the fracture


Tension Band wiring applied

CASE 3: MEDIAL MALLEOLAR FRACTURE

POST OP 4 WEEKS



POST OP 8 WEEKS

CASE 3 - MEDIAL MALLEOLAR FRACTURE

FUNCTIONAL ANGE OF MOVEMENTS

Discussion

DISCUSSION

A fracture may occur in any part of the body due to a varied number of reasons apart from trauma. Depending upon the location and severity of the injury in the bones, fractures could be classified as Simple, Compound, Complicated, Hairline, Greenstick, Comminuted or Avulsion fractures.

The methods of treating bone fractures aims not only in achieving agglutination of the broken fragments of the bone but also maintain the flawless mobility and functions of the joints nearby as before the fracture occurred.

The treatments done to set the bones after a fracture are generally termed as 'Reduction' by medical practitioners. In fractures of lesser severity, the reduction is done by manual procedures while in severe fractures a procedure called as Open reduction internal fixation is done. After this procedure is done, the fractured bones movements are restricted by using a cast. The resting phase is highly mandatory to ensure that the mending takes place in a precise and legitimate manner.

For certain types of fractures a therapeutic procedure called as Tension Band method is used to cure fractured bones. The basic principle in the tension band method is to convert the force applied to the fracture from a tensile force to a compressive force. Specifically tension bands are used to set the fractures which are unsettled and shuffled by muscle pull. In intraarticular fractures of patella, Olecranon and Medial Malleolus it is important to maintain perfect anatomical reduction of fragments to obtain articular congruity by rigid fixation. The distinct advantage of Tension Bands is that it can facilitate a quick solution for the smooth motion of the joints that are involved in the fracture. Thus the resultant outcome for this quick fix solution is much more prominent than most of the other alternatives that are practiced by specialists in Orthopaedics.

Tension banding is a principle and not a particular implant. To apply an implant with a tension band technique, a device is fixed eccentrically to the convex side of the fractured bone. Since a curved structure has a compression side and a tension side when an axial load is applied, the device on tension side neutralizes the forces under an axial load. The essential prerequisite is there must be cortical contact on the compressive side, which is the side opposite to the implant. If there is a cortical defect or comminution on the compressive side, the implant will undergo bending stress and be subjected to early fatigue failure.

A tension band can produce compression statically or dynamically. If a tension band produces fairly constant force at the fracture site during motion, such as at the medial malleolus, it is called a static tension band. Conversely, if the compression increases with motion, such as in the patella with knee flexion, the tension band is called dynamic.

The aim of treatment of fracture is not only achieving union but also to preserve the optimum function of adjacent joints. In intraarticular fractures of patella, olecranon and medial malleolus it is important to maintain perfect anatomical reduction of fragments to obtain articular congruity by rigid fixation. The treatment of choice for these fractures is tension band wiring. Tension band wiring was made use in our 60 cases. It has given favorable results in our experience. The findings, end results and other data will be analyzed and compared in the following discussion

Table 18. Comparison of Outcome with previous studies

Series	Patella				Olecranon				Medial Malleolus			
	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor
Dudani, Sancheti[72]	93.3											
Maini and Kochar[73]	36.6	38.4	15	10	46.2	46.2	7.6					
Pandit, Shah[74]					75	25						
Gary Wolfgang[75]					73	15						
Mathewson[76]					90.48	9.52						
Levack[77]		50	35.7	14.3								
Karra Bansilal[78]	50	40	10	-	60	20	13.3	6.66	-	-	-	-
Reddy KR et al[79]									43.3	30	20	6.7
Present Study	45	40	10	5	30	25	22	25	20	25	20	35

The above table analyzes and evaluates the quality of a ‘tension band wiring’ done for fractures fractures of Patella, Olecranon and Medial Malleolus at different time periods. The values in the table are collected from different studies particularly undergone tension band wiring as a treatment option for the fractures. These values evaluate the quality of tension band wiring as a remedial procedure for fractures especially in the Patella. The records of patients dating back from 1981, who were treated for fractures using this procedure is considered in the tabular column. The treatments had been done by orthopedic surgeons who were responsible for handling fractures at specific areas of the body. The areas were tension band wiring has been normally used over the years are the intraarticular fractures of Patella, Olecranon and Medial Malleolus.

The quality of the treatment is analyzed and evaluated by measuring certain factors such as the conjoining of the bones and the reduced intensity of pain. Responses that were given by the patients are then recorded and depicted in the table by categorizing them into four possible options as excellent, good, fair and poor. These options could more or less reflect the efficiency of a treatment procedure and give others better insight as to how the treatment fared with the patients It was expected that the responses would be a guide for observing and judging the competence of tension band wiring as a treatment option for fractures at different locations in the body. The intensity of the pain could be gauged completely and authoritatively by an experienced orthopedic by asking the patient to move the fractured area cautiously and recording his response about the pain accordingly.

The quality of the bone healing after tension band wiring could be analyzed by imaging techniques like Radiography which depict how completely the bones have conjoined together after the treatment. It would be fair to assume that the values in the tabular columns exactly represent the performance of tension band wiring as a treatment procedure after fractures and could enumerate the subtle differences in its outcome when applied to different areas of the body. The studies reveal that the bone healing capacity of tension band wiring varied to a considerably large degree when it was applied to other areas like Olecrenon and Medial Malleolus apart from the Patella. The values that were recorded for the Patella was fairly consistent throughout the studies conducted and showed an improved bone healing capacity and reduced pain. The quality of the procedure was noticeable during the procedure and after the complete healing of the bones.

The first study which was conducted by Dudani and Sancheti during the year 1981 that gives a comprehensive and elaborate look into the effectiveness of Tension band wiring as a treatment for fractures at different parts including the Patella. The results depicted in the tabular column simulate statistical data that could be used to gain more knowledge and insight about the effectiveness of the procedure. The study by Dudani and Sancheti concentrates only in the Patella and does not enumerate the effectiveness of tension band wiring in Olecrenon and Medical Malleolus. It could be seen from the table that the effectiveness of the procedure was close to 93.3% which shows the efficiency of the procedure as a fix for serious fractures.

The study conducted by Mainin and Kochar compares the effectiveness of tension band wiring in both the Patella and Olecrenon. The study demonstrates that the effectiveness of the procedure was exceptional when it was applied to the Patella as compared to the other two areas. It was illustrated that generally the procedure was exceptional in its healing capacity and pain reduction ability after the fracture. It could be deciphered from the table that the effectiveness of the procedure was around 75% in the Patella (38.4% good and 36.4% excellent). The same study showed the procedure was fairly good for fractures in Olecrenon too. The procedure got an overall rating of around 92% for its efficiency. The excellent and good rating summed up to around 46.2% each for the procedure.

The studies by Pandit and Shah, Gary Wolfgang and Mathewson does not take into consideration the tension band wirings effect on Patella and Medial Malleolus. But both these studies report the effectiveness of the procedure in Olecrenon. The study depicts the effectiveness of tension band wiring and quantifies its overall effectiveness at around 99.52%. The treatment procedure had got an excellent rating of 90.48% and a good rating at 9.5% for its bone healing abilities and pain reduction capacity

In Levacks study, the procedure was given an excellent rating of 50% for its positive attributes. The ratings also quantified the procedures efficiency at 35.7% as fair based on different criterions. The efficiency of the procedure was again rated as poor at 14.3%. Such a negligible percentage reestablishes the procedures capacity as an excellent treatment option for fractures at the patella.

Karra Bansilal similarly made a study of the effect of tension band wiring on Patella and Olecrenon simultaneously. This study again showed the benefits of the procedure at the Patella and assigned a positive rating of 90% for the procedure. The breakup percentages showed that 50% was excellent while 40% was assigned as good.

The last row in the table discusses about the current study and compares it with the earlier studies done by researchers from 1981 onwards till 2016. It could be seen from the table that the effectiveness of tension band wiring as a treatment procedure was impressive and persuasive. The effectiveness of the procedure was recorded at 85%, for patella which was one of the highest ratings assigned to the procedure. This again reinstates the quality of tension band wiring as a procedure that could be practiced as a fix for serious fractures at different parts of the body especially the Patella. Considering the incidence of knee fractures and the time taken for the Patella to heal, it is imperative to have studies which demonstrate the effectiveness of the procedure.

Conclusion

Conclusion

CONCLUSION

It was concluded from the present study that:

Tension band wiring by principle overcomes the distractive force, achieves compression at the fracture site and maintains the alignment by minimum hardware.

By achieving compression at fracture site, the fracture heals faster and the patient is back to work earlier.

The fixation enables early active movements of joints as early as four weeks when the fracture is healing, which reduces joint stiffness.

The long-term complications of prolonged immobilization like joint stiffness, muscle wasting, pressure sores, and osteoporosis are avoided. Hence, it is concluded that tension band wiring is a simple, inexpensive technique and effective means of fixing fracture based on biomechanical principle with minimum complications.

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Appendices

ANNEXURE – I

SREE MOOKAMBIKA INSTITUTE OF MEDICAL SCIENCES
KULASEKHARAM

RESEARCH COMMITTEE

CERTIFICATE

This is to certify that the Research Protocol Submitted by Ansar Muhammad . S

~~Faculty~~ / Post Graduate from Department of Orthopaedics *Titled* "Functional outcome of tension band wiring of transverse fracture of Patella, Olecranon & ~~Bimalleolar~~ medial malleolus"

Gnanadhas 9/2/15

is approved by the Research Committee.

Gnanadhas 27/1/15

Chair Person

Prof. & H.O.D.
Dept. of Bio-Chemistry
Sree Mookambika Institute of Medical Sciences
Kulasekharam 629 161

Convenor

Prof. & H.O.D.
Dept. of Physiology
Sree Mookambika Institute of Medical Sciences
Kulasekharam 629 161

Date : 27/1/15

INSTITUTIONAL HUMAN ETHICS COMMITTEE
SREE MOOKAMBIKA INSTITUTE OF MEDICAL SCIENCES,
KULASEKHARAM, TAMILNADU

Communication of Decision of the Institutional Human Ethics Committee(IHEC)

SMIMS/IHEC / 2015/A /37

Protocol title: FUNCTIONAL OUTCOME OF TENSION BAND WIRING OF TRANSVERSE FRACTURE OF PATELLA OR OLECRANON OR MEDIAL MALLEOLLUS
Principal Investigator: Ansar Muhammad.S
Name& Address of Institution: Department of Orthopaedics Sree Mookambika Institute of Medical Sciences ☑ New review ☐ Revised review ☐ Expedited review
Date of review (D/M/Y): 13-03-2015 Date of previous review , if revised application:
Decision of the IHEC: ☑ Recommended ☐ Recommended with suggestions ☐ Revision ☐ Rejected
Suggestions/ Reasons/ Remarks:
Recommended for a period of : Eighteen months

Please note*

- Inform IHEC immediately in case of any Adverse events and Serious adverse events.
- Inform IHEC in case of any change of study procedure, site and investigator
- This permission is only for period mentioned above. Annual report to be submitted to IHEC.
- Members of IHEC have right to monitor the trial with prior intimation.

Reneega

Signature of Member Secretary (IHEC)

SREE MOOKAMBIKA INSTITUTE OF MEDICAL SCIENCES ★ KULASEKHARAM ★ IHEC Date..........

ANNEXURE – II

CONSENT FORM
PART 1 OF 2
INFORMATION FOR PARTICIPANTS OF THE STUDY

Dear Volunteers,

We welcome you and thank you for your keen interest in participating in this research project. Before you participate in this study, it is important for you to understand why this research is being carried out. This form will provide you all the relevant details of this research. It will explain the nature, the purpose, the benefit, the risks, the discomfort, the precautions& the information about how the project will be carried out. It is important that you can read and understand the contents of the form carefully. This form may contain certain scientific terms and hence, if you any doubts or if you want any information you are to ask the study personnal or the contact person mentioned below before you give the consent and also at any time during the entire course of the project .

1.Name of the Principal Investigator: Dr. ANSAR MUHAMMAD. S
Postgraduate-M.S Orthopaedics
Sree Mookambika Institute of Medical Sciences
Kulasekharam.
Mob: 9787887241
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5. Institute details with address : Sree Mookambika Institute of Medical Sciences
Kulasekharam, Padanilam, Kanyakumari district
Pin - 629161 TAMILNADU

6. Title of the study:

Functional outcome of tension band wiring of transverse fracture of Patella or Olecranon or Medial malleolus.

7. Background information:

Fracture of Olecranon or Patella or Medial Malleolus ankle are most commonly seen in today's life. So tension band wiring is the best treatment modalities that help the patient to recover functionally at earliest.

8. **Aim and Objectives:**

- To assess the functional outcome of tension band wiring in transverse fracture of Patella, Olecranon & Medial malleolus.

9. Scientific justification of study:

- It is the major problem in today's life.
- Gap of knowledge regarding the tension band wiring in Patella or Olecranon or Medial Malleolus
- Only few study had done on tension band wiring in Patella or Olecranon or Medial Malleolus

10. Procedure of the study:

Here we will consult and examine the patient in OPD of orthopaedics & casualty in Sree Mookambika Institute of Medical Science, Kulasekaram. Detailed history and the physical examination regarding the fracture of Patella or Olecranon or Medial Malleolus, confirmed by taking x-ray then general physical examination will be performed.

During the surgery the tension band will be fixed for fracture of Patella or Olecranon or Medial Malleolus. After the surgery details will be noted in the proforma with the help of scoring system. Patient will followed in every week and in each follow up details will be noted in the proforma with help of scoring system.

11. Expected risk of the participant: Chances of post operative infection, fixation failure, re-fracture, loss of knee motion, anaesthetic complications like hypo tension, post dural puncture headache may occur.

12. Expected benefits of the research for the participants: Better treatment.

13. Maintenance of confidentiality: All the data collected for the study will be kept confidentially and would reflect on general statistical evaluation only would not reveal any personal details.

14. Why have I been chosen to be in this study: You have fracture of patella /olecranon/ medial malleolus

15. How many people will be in the study: 60

16. Agreement of compensation to the participants: No

17. Anticipated prorated payment, if any, to the participants of the study: Nil

18. Can I withdrawn from study at any time during the study period: Yes

19. If there is any new finding /information would I be informed: Yes

20. Expected duration of the participants participation in the study: Periodic

21. Any other pertinent information: No

22. Whom do I contact for further information:

For any study related queries, you are free to contact

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Post Graduate, Department of Orthopaedics
Sree Mookambika Institute of Medical Science
Kulasekharam,629161
Mobile no:9787887241
e-mail:anzarmhds@gmail.com

Place : Signature of Principal investigator

Date :

Signature of participant

CONSENT FORM

PART 2 OF 2

PARTICIPANTS CONSENT FORM

The details of the study have being explained to me in writing and details have being fully explained to me. I am aware that the results of the study may not be directly beneficial to me but will help in the advancement of the medical sciences. I confirm that I have understood the study and had the opportunity to ask questions. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reasons, without the medical care that normally is provided by the hospital being affected. I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purposes. I have given the details of the study. I fully consent to participate in the study titled “Functional outcome of tension band wiring of transverse fracture of Patella or Olecranon or Medial malleolus” in a tertiary medical care centre, Kulasekharam.

Serial number/ reference no.:

Name and address of the participant:

Contact no. of the participant:

Signature/ Thumb impression of the participant

Witness:

1.
2.

Date :

Place: Kulasekharam

ANNEXURE III

PROFORMA

SREE MOOKAMBIKA INSTITUTE OF MEDICAL SCIENCES

Padanilam, Kulasekharam, K.K. Dist, Tamilnadu – 6291 61

DEPARTMENT OF ORTHOPAEDICS

Functional outcome of tension band wiring of transverse fracture of Patella or Olecranon or Medial malleolus

CASE RECORD FORM

Preliminary details:

- Name -
- Age -
- Sex -
- IP No -
- Occupation -
- Address -

- Date of admission -
- Date of surgery –
- Date of discharge -

Chief Complaints :

History of presenting illness :

Past history :

Family history :

Personal history:

On examination:

Surgery details:

X Ray:

1. Pre op
2. 4weeks
3. 8 weeks
4. 12 weeks

COMPLICATIONS:

1. Stiffness
2. Skin necrosis
3. Infection
4. Others

KNEE SCORING

Sl. No		Pre OP	4 weeks	6 weeks	8 weeks	10 weeks	12 weeks	14 weeks	16 weeks	18 weeks
1.	Quadriceps Wasting									
2.	Quadriceps Power loss									
3.	Extension lag									
4.	Knee range of motion									
5.	Knee pain									

ANKLE SCORING

Sl. No		Pre OP	4 weeks	6 weeks	8 weeks	10 weeks	12 weeks	14 weeks	16 weeks	18 weeks
1.	Pain									
2.	Function									
3.	Alignment									

ELBOW SCORING

Sl. No		Pre OP	4 weeks	6 weeks	8 weeks	10 weeks	12 weeks	14 weeks	16 weeks	18 weeks
1.	Pain									
2.	Motion									
3.	Stability									
4.	Function									

MASTER CHART

S.No	Name	Age	Sex	Fracture Side	Mechanism of Injury	Mode of Injury	Associated Injury	Radiological Union in Weeks	Pain	Complications	Results
1	Sanjay	28	M	Ol(Rt)	D	ASL	Nil	15	+	Nil	Fair
2	Rajan	40	M	Ol(Lt)	D	RTA	Nil	12	Nil	Nil	Good
3	Sowmya	22	F	Ol(Rt)	I.D	DN	Nil	10	Nil	Nil	Good
4	David	35	M	Ol(Rt)	D	ASL	Nil	11	Nil	Nil	Excellent
5	Sujay	24	M	Ol(Rt)	I.D	DN	Nil	8	Nil	Nil	Fair
6	Suresh	35	M	Ol(Lt)	I.D	DN	Nil	10	Nil	Nil	Excellent
7	Mohan	38	M	Ol(Rt)	I.D	DN	Nil	12	Nil	Nil	Excellent
8	Divya	21	F	M.M(Rt)	D	RTA	Nil	11	+	Nil	Fair
9	Thankaraj	40	M	M.M(Lt)	I.D	DN	Nil	10	Nil	Nil	Excellent
10	Jishnu	31	M	M.M(Lt)	I.D	DN	Nil	11	Nil	Nil	Good
11	Megala	35	F	M.M(Rt)	I.D	DN	BM	11	+	K.wire Migration	Poor
12	Ravi	38	M	M.M(Lt)	I.D	SPR	BM	18	+	Infection	Poor
13	Vishwanathan	35	M	M.M(Rt)	D	RTA	Nil	15	+	Nil	Good
14	Thomas	46	M	M.M(Rt)	I.D	DN	Nil	18	+	Infection	Poor
15	Basheer	40	M	M.M(Rt)	I.D	DN	Nil	8	Nil	Nil	Excellent
16	Ramaraj	60	M	M.M(Rt)	I.D	DN	Nil	10	Nil	Nil	Fair
17	Nisar	35	M	M.M(Rt)	I.D	DN	Nil	11	Nil	Nil	Good
18	Rohini	40	F	M.M(Lt)	D	RTA	Nil	11	Nil	Nil	Excellent
19	Akshay	21	M	M.M(Rt)	I.D	RTA	Nil	12	+	Nil	Poor
20	Sahayam	55	M	M.M(Lt)	I.D	DN	Nil	11	Nil	Nil	Excellent
21	Mary	60	F	L.Patella	I.D	RTA	Nil	10	+	K.wire Migration	Poor

22	Akila	21	F	L.Patella	D	RTA	Nil	9	Nil	Nil	Good
23	Vincent	41	M	R.Patella	D	RTA	Nil	8	Nil	Nil	Good
24	Sunder	30	M	L.Patella	I.D	DN	Nil	12	Nil	Nil	Excellent
25	Arulraj	54	M	L.Patella	I.D	DN	Nil	11	Nil	Nil	Excellent
26	Arumugam	49	M	L.Patella	D	RTA	Nil	11	Nil	Nil	Excellent
27	Basha	60	M	R.Patella	I.D	RTA	Nil	8	Nil	Nil	Excellent
28	Roswin	34	M	L.Patella	I.D	RTA	Nil	11	Nil	Nil	Excellent
29	Manish	37	M	R.Patella	I.D	DN	Nil	11	Nil	Nil	Excellent
30	Leema	36	F	L.Patella	D	RTA	Nil	8	+	Nil	Fair
31	Sundar	45	M	Ol(Lt)	I.D	RTA	F	15	+	Stiffness	Poor
32	Stalin Jose	34	M	M.M(Rt)	I.D	ASL	Nil	12	Nil	Nil	Good
33	Sini	26	F	R.Patella	D	ASL	Nil	11	Nil	Nil	Good
34	Subramanian	43	M	Ol(Rt)	D	DN	Nil	12	Nil	Stiffness	Fair
35	Praveen	30	M	Ol(Rt)	D	RTA	Nil	11	Nil	Nil	Excellent
36	Thankamma	53	F	Ol(Lt)	D	ASL	Nil	11	Nil	Stiffness	Fair
37	Murugesan	42	M	R.Patella	D	ASL	Nil	11	+	Nil	Good
38	Suresh	29	M	Ol(Lt)	D	DN	Nil	12	Nil	Nil	Good
39	Selvarani	48	F	R.Patella	I.D	RTA	Nil	8	+	Nil	Good
40	Thankappan	56	M	M.M(Rt)	D	DN	Nil	18	+	Skin Necrosis	Poor
41	Dani	24	M	Ol(Lt)	D	ASL	Nil	11	Nil	Nil	Good
42	Reena	31	F	R.Patella	D	ASL	Nil	9	Nil	Nil	Excellent
43	Davison	36	M	M.M(Rt)	I.D	DN	Nil	12	Nil	Nil	Good
44	Shiji	23	F	Ol(Lt)	I.D	DN	Nil	11	Nil	Nil	Excellent
45	Symon	25	M	Ol(Rt)	D	ASL	D	15	+	Stiffness	Poor
46	Sudaram	39	M	Ol(Rt)	D	RTA	Nil	12	Nil	Nil	Excellent

47	Sujatha Bai	35	F	M.M(Rt)	D	RTA	Nil	12	Nil	Nil	Fair
48	Sreejith	25	M	R.Patella	I.D	RTA	Nil	9	Nil	Nil	Good
49	Mohan	44	M	L.Patella	I.D	RTA	Nil	10	Nil	Nil	Good
50	Nagarajan	29	M	Ol(Lt)	I.D	RTA	Nil	15	+	Stiffness	Poor
51	Suresh Kumar	49	M	Ol(Lt)	I.D	SPR	Nil	18	+	Stiffness	Poor
52	Monish	30	M	R.Patella	D	RTA	Nil	8	+	Stiffness	Fair
53	Roseline	36	F	M.M(Rt)	D	RTA	Nil	15	+	K.wire Migration	Poor
54	Vijaya Kumar	47	M	R.Patella	D	ASL	Nil	11	Nil	Nil	Excellent
55	Sounder	33	M	Ol(Lt)	D	DN	Nil	11	Nil	Nil	Good
56	Manthira Moorthi	35	M	R.Patella	I.D	DN	Nil	10	Nil	Nil	Good
57	Ponnamal	51	F	M.M(Rt)	I.D	ASL	Nil	12	Nil	Skin Necrosis	Fair
58	Mohanan Raj	46	M	R.Patella	D	RTA	Nil	8	Nil	Nil	Excellent
59	Stephen	36	M	Ol(Lt)	I.D	RTA	Nil	18	+	Stiffness	Poor
60	Sathiyadhas	47	M	M.M(Rt)	D	ASL	Nil	12	+	K.wire Migration	Poor

Fracture/Side: Fracture of bone patella is denoted by (PT), Olecranon by (OL), medial malleolus by (MM). Side of fracture by Right as (R) and Left as (L).

Mechanism: Mechanism of injury by Direct as (D) and Indirect by (ID)

Mode of injury: Domestic in Nature (DN), Road traffic accident by (RTA), Assault by (ASL), Sports by (SPR).

Associated injury: Bimalleolar fracture by BM, Femur fracture by (F), Dislocation by (D). No associated injury denoted as nil.

Pain: Pain at 12 weeks denoted by mild (+), moderate (++), severe (+++). No pain by (-).

Complications: They are mentioned. No complications by nil.

Union: Radiological time for union of fracture in weeks.

Results: According to criteria laid down results are denoted as Excellent (E), Good (G), Fair (F) and Poor (P)